PSYCHOLOGY AND THE SCHOOL

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PSYCHOLOGY AND THE SCHOOL

BY

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EDITOR'S INTRODUCTION

All schools preparing students for the profession of teaching, whether Normal Schools or Colleges of Education, are agreed that it is fundamentally necessary for these students to take as an elementary subject, practically prerequisite to all other educational courses, work in educational psychology. Psychology, as it is ordinarily taught in an elementary way, contains little, if any, special application to the problems of teaching. Indeed, the general problem of learning is approached in so indefinite a way in most of these books that the student who has not worked with specific courses of educational psychology is at a loss in the discussion of specific problems which have to do with the technique of teaching.

This volume of Professor Cameron's has been prepared to meet the specific needs of those preparing to teach. As it includes a reasonably comprehensive introduction to psychology, it is possible for students to work with this book to advantage, who have not had introductory courses in general psychology. It has the additional advantage of considering elementary psychological principles specifically from the standpoint of the teacher and the [illegible]er.

Throughout the book, technical and theoretical discussions are avoided, the primary purposes of the author being to give the explanation of the behavior of school children in terms of the mental life. This volume is presented in the belief that it will be of value to colleges and normal schools where there is felt to be little demand for the students to take courses in general psychology before beginning the specific task of the application of psychology to education.

CHARLES E. CHADSEY.

PREFACE

THIS book is designed for students of education and teachers who have no previous knowledge of psychology. The earlier chapters (I-XI) cover the ground usually treated in text-books of general psychology but with the emphasis on the application of psychological principles to education. The remaining chapters are more specifically designed to treat the applications of psychology to education in some detail.

The book is written throughout from the functional point of view though not leaning to behaviorism in its extreme form.

My obligations to writers are numerous but I have endeavored to give proper acknowledgments in each case. I am under special obligation to Professor C. H. Judd, from whom I have borrowed directly at many points, and the influence of whose writings and teaching pervades the entire book.

My thanks are also due to my colleagues, Dean C. E. Chadsey and Mr. C. W. Krusé, who have read the manuscript and offered many criticisms and suggestions.

E. H. CAMERON.

Urbana, Ill., Aug. 10, 1921.

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PSYCHOLOGY
AND THE SCHOOL

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CHAPTER I

INTRODUCTION

Psychology defined. — Psychology is the science that describes and explains conscious processes and their relationship to the behavior of man and other animals. Any one may know what is meant by a conscious process by appealing to his own experience. As long as we are awake, and very often while we are asleep, we are conscious, that is, there is a continuous stream of perceptions, memories, thoughts, feelings, and other sorts of conscious processes passing on within us. The sum total of these conscious processes we call mind.

Bodily and mental functions are not separate. — While the problem of psychology is the investigation of these mental processes, its purpose must not be conceived too narrowly. The mind is closely related to the body. Conscious processes cannot be properly understood and explained without taking bodily

processes into account. This close relationship is especially apparent when we raise such questions as, "What is the mind or consciousness for? What purpose or function does it play?" In a general way the answer to these questions must be that consciousness exists for the sake of its influence on action. Our minds influence our behavior so as to bring us into more favorable relationships to our environment. The separation of our organisms into mind and body is an artificial separation. As they actually exist they are indissolubly connected. The mind's functions cannot be properly understood without taking into account the bodily functions; nor can behavior be fully explained without relating it to the conscious processes with which it is connected.

Psychology the only science that includes mental processes in its explanations. — There are other sciences, such as biology, that aim to explain why animals behave as they do; but such sciences do not include conscious processes in their explanations. There is every reason to believe that the lower animals share with man in having conscious experiences. How far down in the scale of animal life we have to go to find animals without consciousness cannot be told with exactness; but most of the lower forms of life are so similar to man in their structure and modes of behavior as to imply that they possess some degree or kind of consciousness.

The behavior of the simplest animals. — Even the

lowest forms of animal life, the unicellular organisms, perform in a simple manner all the important functions found in higher kinds of animals. Take, for example, the paramecium. These one-celled microscopic animals swim around in the water in which they live, taking in food which, as in higher forms of life, is used for furnishing energy and replacing the waste of the body substance. While the paramecium usually swims forward in search of food, it has another kind of behavior under certain circumstances. It avoids certain situations, such as those caused by obstructions or the presence of a drop of salty water introduced by the experimenter. This reaction of avoidance consists of backing up for a short distance and then turning in a slightly different direction before proceeding on its way.

Sensitivity, conductivity, and contractility. — From such a simple account of one of the lowest forms of animal life there may be obtained some ideas to guide us in our further study. We have, first of all, a living organism (paramecium) in a certain environment (water) in which it lives. The way in which the animal behaves is determined by two factors—its own nature and the changing conditions of the environment. It may be inferred from the observation of the behavior of the paramecium (1) that it is affected by (sensitive to) changes in its environment; (2) that the effects of the environmental changes are conducted from the part of the animal's body where they are re-

ceived to other parts; and (3) that these parts move (contract) as a result. These three functions of sensitivity, conductivity, and contractility are found in all living organisms, and are of special concern in the study of psychology. Whether the paramecium has also the function of consciousness we can only surmise; but in human beings, where we know that consciousness is present, it is always related more or less directly to these three functions, sensitivity, conductivity, and contractility.

Specialization of functions. — In the unicellular animals all these functions are performed by one cell. But the multicellular animals are made up of different kinds of cells, each with its special function. The cells that are specialized for contractility form in the aggregate the muscular system of higher animals. The cells that are specialized for sensitivity are distributed for the most part over the surface of the body, and in some cases take the highly specialized forms of sense-organs. The cells that are specialized for conductivity taken together form the nervous system, and serve to connect the sensitive cells with the contractile (muscular) cells. The higher in the scale of animal evolution, the more numerous and highly specialized these cells become, and the behavior is correspondingly more varied. All of this development is clearly for the purpose of better adaptation of the animal to its environment.

Relation of consciousness to these functions. — Somewhere in the course of this development the addi-

tional function of consciousness appears, and is added as one link in the chain leading to behavior. It is not necessary for our purposes to attempt to discover at just what point in animal evolution consciousness appears, since it is with the conscious processes of human beings that we are mainly concerned. When they do appear, however, they are not isolated and apart from the rest of the organism. They do not exist simply for their own sake, but for the sake of providing more successful and varied reactions to the environmental conditions.

Mental processes not identical with brain processes. — It may, therefore, be stated as a general conclusion—which, however, must be left to further study to justify fully—that no conscious process occurs without corresponding bodily changes. Let us take a concrete example. We are continually, in the course of our waking life, engaged in seeing objects around us. Let us suppose that a moment in consciousness has been devoted to the experience that we call "seeing" a book. Every one knows that seeing the book is dependent upon some effect that the book has upon the eye and the optic nerve leading from the eye to the brain. Now, all the changes taking place in the eye, the optic nerve, and the brain, are bodily changes and are the necessary conditions for the conscious experience of seeing the book. Furthermore, the person seeing the book is likely to act in some definite way toward the book, as when the arm is extended and the hand takes

the book. Such an action is, of course, due to a series of bodily changes in muscles, nerves, and brain, all of which are again related to the conscious experience of seeing.

At this point the student should be warned against making the mistake of identifying the conscious process with any of its bodily conditions. We often speak of brain processes as if they were identical with mental processes, and our thoughts are said to be in our heads. It must be remembered, however, that a mental process is a unique sort of fact, quite different from the physical brain processes. It occurs in the head only in the sense that it depends on brain processes that take place there.

Unique character of mental process. — The distinction between brain processes and conscious processes is well stated in the following quotation from Royce:

Were physiologists better endowed with sense-organs and with instruments of exact observation, we can, if we choose, conceive them as, by some now unknown device, coming to watch the very molecules of our brains; but we cannot conceive them, in any possible case, as observing from without our pains or our thoughts in the sense in which physical facts are observable. Were my body as transparent as crystal, or could all my internal physical functions be viewed and studied as easily as one now observes a few small particles eddying in a glass of nearly clear water, my mental states could not even then be seen floating in my

brain. No microscope could conceivably reveal them. To me alone would these states be known. And I should not see them from without; I should simply *find* them, or *be aware* of them. And what it is to find them, or to be aware of them, I alone can tell myself.

Introspection direct observation of mind. — Psychology, like any other science, begins by careful observation of its facts. Casual observation is seldom accurate enough to be scientific, and in the case of conscious facts we rarely take the trouble to observe them carefully. The conscious experience does not appear to exist for its own sake, but rather for the sake of directly or indirectly putting us in touch with our surroundings. Much of consciousness is taken up with reporting to us changes in the world around us, thus preparing us for activities suitable to these changes. In such cases we are chiefly interested in what consciousness reflects to us of the external world rather than in the nature of the conscious process that reveals this knowledge. To observe carefully the conscious process as it occurs is therefore somewhat unnatural; but it is nevertheless the only method we have of getting first hand direct knowledge of consciousness. Such observation of one's own conscious processes is called introspection (literally, "looking within").

Mind indirectly observable through behavior. — It is clear that one cannot observe the mental processes of others by the method of introspection. Indeed, it is, as we have seen, one of the distinguishing marks

of conscious processes that they belong to the individual experiencing them, and to him alone. For example, if a person is angry, you may infer that such is the case from his appearance and behavior; but the anger itself is *his* experience and *directly* observable by him only. This illustration will serve to show that we can observe the consciousness of others only *indirectly* through the observation of their behavior.

Both methods necessary. — The direct and indirect methods of observing consciousness must go hand in hand and supplement each other. Introspection is unnatural until we have had much practice, and even after much practice is difficult and fails to reveal many of the facts. On the other hand, the facts obtained by the method of indirect observation frequently have to be interpreted in the light of what is known of one's own experience gained through introspection.

Illustration from child psychology. — The relation between these two methods of observation is well brought out by a reference to a special field of psychology, which has a vital relation to education, *viz.*, child psychology. To observe the facts of the child's consciousness is possible only through the observation of his many forms of behavior. Even in those cases where the child is old enough to describe his own conscious processes by means of speech, it must be remembered that speech is, from the point of view we are now taking, merely a form of behavior. This may introduce an error into the conclusion if great care is not taken

in the interpretation of the child's behavior, since in many cases it is difficult to think oneself back into the consciousness of one's own childhood. The adult's and the child's behavior may be very much alike in some respects, but it would be unwise to jump to the conclusion that the conscious process back of the behavior is the same in the two cases. A child a month old may smile in response to the smile of his mother or nurse in much the same way as would an adult under similar circumstances; but it is absurd to suppose that a child of that age has any such realization of the significance of his behavior as has the adult.

Explanation by analysis. — To explain a fact is to make it clear by showing the conditions under which it makes its appearance. The various sciences use various methods of explanation. Thus the chemist may show the conditions under which water makes its appearance by analyzing it into its constituent elements of hydrogen and oxygen. Analysis of complex mental processes into their elements is one of the chief methods of explanation in psychology. It is, of course, impossible to analyze a mental process into simpler elementary parts that can be actually separated from one another, as can the hydrogen and oxygen of water. Nevertheless, the analysis of a mental process may take place by merely observing the various constituent elements, just as one may observe the various parts of a complex piece of machinery without taking the machinery apart.

Explanation by bodily conditions. — A second method of explaining psychological processes is by relating them to the various bodily conditions with which they are connected. The physiological processes connected with the eye help to explain the conscious experience of seeing, since the former is a condition of the latter. The relationship between bodily processes and mental processes is much wider than would be supposed without special study, and to trace the details of these relationships constitutes one of the most important tasks of modern psychology.

Relation of psychology to teaching. — It may be safely said that no teacher can fail to understand both the child and the nature of the learning process better for having acquired a knowledge of the fundamental principles of psychology. We all possess in a greater or less degree glimmerings of psychological knowledge that we have not been taught by books; but in order that we may not make mistakes we need a precise knowledge of the facts and laws of mind in general, and especially of the mind of the child of school age. While a teacher may perhaps be a good teacher without knowing psychology, he cannot afford to neglect the sciences that underlie the art of teaching, any more than the physician can afford to neglect physiology and anatomy, however much native skill he may have in the art of healing.

Education defined. — When we speak of education we usually refer to certain effects on the child produced

by teachers and schools. A little reflection, however, will show that these effects are not different in kind from many of the changes brought about in the child by his life outside of school. The child is by nature a learner; that is, every experience he undergoes leaves its effect, however small it may be, and he will act differently in the future because of the experience. Broadly speaking, education is the sum total of the conscious changes effected in a child by his environment, and the evidence of this education is the way in which he acts in the various situations in which he finds himself.

Environment produces the educative effects. — But the environment of the child is very complex and varied. It includes not only the natural physical objects, such as land and water, trees and stones, sky and stars, but objects made by man's hands—buildings, machinery, and works of art. It includes also other persons and what they say and do and have written—language, science, history. In a word, the child's environment consists of everything outside of himself that affects him in such a way as to change his behavior.

Psychology the scientific foundation for education. —It is the task of the educator to place the child in the best environment to insure the greatest possible efficiency in meeting his life's needs and those of his fellow man. In education, in the narrower sense of the word, there is a conscious selection of the environmental forces that are supposed to be most fa-

vorable for the child's development. This task can be successfully accomplished only when we know what the child's nature is to begin with, and what effects may be expected from the experiences through which he passes. It is the purpose of psychology to investigate such conditions and effects, and to show how and why the child responds to the various environmental forces.

Necessity of clearly understanding terms. — There are a few errors to which the beginner in psychology is prone that may perhaps be avoided if they are clearly pointed out at the start. Much of the confusion that sometimes comes upon the student is due to lack of understanding terms. We are continually using such terms as perceive, imagine, remember, think, and the nouns corresponding to these verbs, in our ordinary conversation. The psychologist uses these same terms, but in a technical sense that is more precise than the meaning given in every-day speech. If the student, however, neglects the more precise meaning of the psychological terms simply because of his familiarity with their meanings as commonly used, he is very likely to fall into error and confusion. Try, therefore, to discover the precise meaning of all psychological terms as they are met in the succeeding pages. The attempt is made to define each term as it appears. No such hard and fast definitions, however, can do justice to the facts. They should be regarded merely as starting-points in the description of the processes involved.

Confusion of brain processes with mental processes. — Another source of trouble to the student beginner of psychology is often the confusion of conscious processes with brain processes. This is the more likely to be the case since the introduction to the study of psychology is usually made through a description of the nervous system, a plan that will be followed in our own treatment of the subject. We have already pointed out in a general way the justification for introducing this material, which is, strictly speaking, physiological, into a text-book on psychology. A knowledge of the nervous system helps us to explain the facts of consciousness. The psychologist is, therefore, interested in the nervous system not so much for its own sake as for the light it throws upon consciousness.

Difficulty of the introspective point of view. — A third source of difficulty is inherent in the nature of psychology itself. It is the difficulty of adopting the psychological or introspective point of view. As has already been pointed out, it is not usual to observe conscious processes carefully, because they seem to be but a means to an end. We see and hear things, not for the sake of the seeing and hearing experiences themselves; rather are we interested in the objects reported to consciousness and in adopting the appropriate behavior toward these objects. Observation of seeing and hearing as conscious processes is, therefore, somewhat difficult because unusual. The student should practise introspection. Stop two or three times in the

course of the day and try to observe what is passing through your mind. Try to verify descriptions of this book in your own experience.

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CHAPTER II

THE NERVOUS SYSTEM

Meaning of behavior. — Behavior, in the last analysis, is merely muscular action, sometimes relatively simple, sometimes complex, sometimes resulting in movement, sometimes in lack of movement by the balancing of the contracted muscles against one another.[1] But the muscles do not act of their own accord: they act more or less directly in relation to the functioning of the sensitive parts of the body. The entire surface of the body is sensitive to objects coming into contact with it, and the higher animals have special sense-organs capable of responding to such environmental changes as those that occur in the form of ether waves and air waves.

General purpose of the nervous system. — The nervous system is a mechanism for connecting sensitive parts of the body with muscles, so that the animal's behavior may be made in relation to what is happening in its environment. An environmental happening that actually affects a sensitive part of the body is called a *stimulus*. The stimulus, by its effect on the

[1] The term behavior is sometimes used, as by Thorndike, to mean the whole series of organic activities (including conscious processes) that lead to muscular action.

sense-organ, produces a *nervous impulse,* which passes through the nervous system and discharges into the

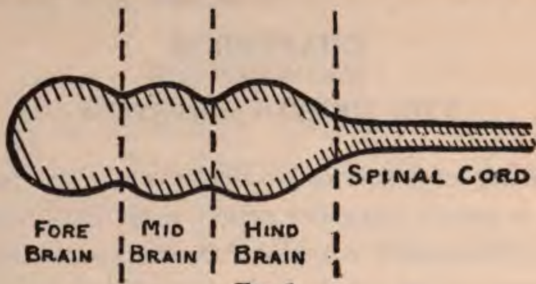

FIG. 1.

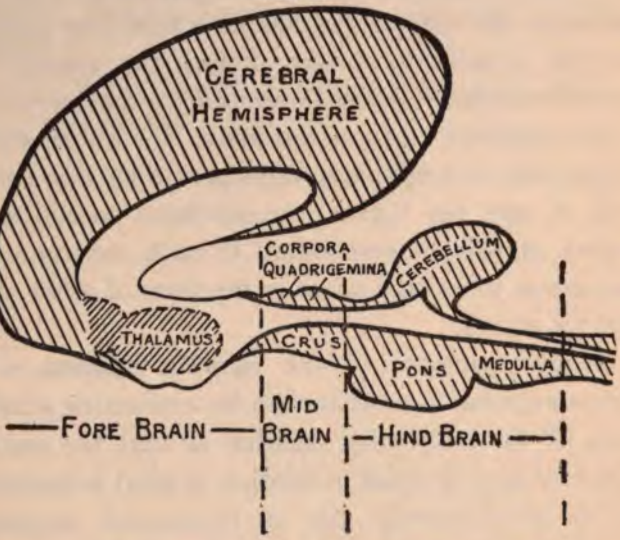

FIG. 2.

FIG. 1. The original neural tube. FIG. 2. A later stage of development. The figure shows the chief structures of the fore-brain, mid-brain and hind-brain. (After Lickley.)

muscle. The main purpose of this chapter is to show some of the typical ways in which the muscles and

sense-organs are connected in man, or, in other words, to trace the paths that nervous impulses travel. Before this can be done, however, it will be necessary to describe the nervous system as a whole and the various parts of which it is composed.

Embryonic development of the nervous system. —

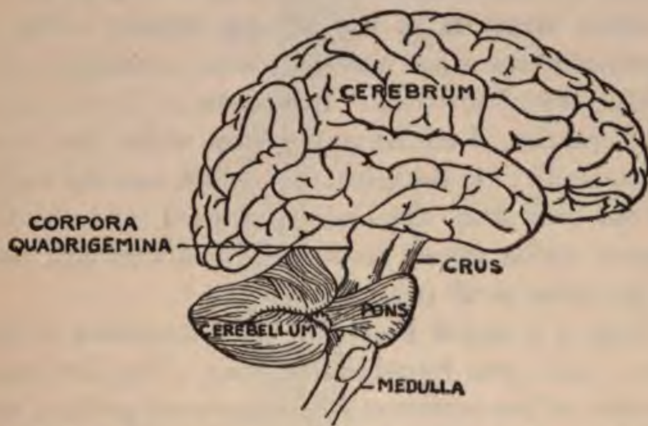

FIG. 3. The fully developed nervous system. The drawing exaggerates the separation between the fore-brain and hind-brain, in order to show the mid-brain.

Very early in the life of the human embryo the nervous system consists of a hollow sac filled with liquid and occupying a position corresponding to the middle of the back. The end of this tube toward the head expands to form three bulbs, as shown in Fig. 1, and these bulbs become eventually the fore-brain, midbrain, and hind-brain of the developed nervous system. The walls of this tube thicken, the liquid is

largely though not wholly absorbed, and the tube becomes more or less twisted in the course of its growth. This twisting is due chiefly to the very great development of the fore-brain region, which presses back and over the mid- and hind-brain regions, as shown in Fig. 2. By the time of birth the whole structure has attained the appearance shown in Fig. 3 on page 19.

Gross structure of the nervous system. — Fig. 4 presents a view of the nervous system in relation to the other parts of the body. It consists of (1) the brain (that portion of the nervous system within the bones of the skull); (2) the spinal cord, which runs the length of the back from the brain downward, and (3) the nerves, which spread from the spinal cord and base of the brain to all parts of the body.

Figures 2 and 3 show the chief structures of the fore-, mid-, and hind-brain regions. The fore-brain consists of the cerebrum, the uppermost portion, and the thalamus, which is below and completely hidden by the cerebrum when viewed from the exterior as represented in Fig. 3. The mid-brain region, which is relatively very small, consists of the corpora quadrigemina (behind) and the crura (in front). The mid-brain is, in fact, completely enveloped by the cerebrum, as in Fig. 4. Fig. 3 exaggerates the degree of separation between the various regions in order to show the relation of the parts. The hind-brain consists of the cerebellum, at the back of the head; the pons, at the front, and the medulla, a thickened por-

tion of the spinal cord at the point where it enters the skull. All of the structures of the brain below the cere-

FIG. 4. General view of the nervous system, showing its relation to other parts of the body. The figure shows a section of one of each pair of spinal nerves, which radiate to all parts of the body. The cerebral nerves, attached to the base of the brain, are not shown in the figure. (From Angell, by permission of Henry Holt and Company.)

brum may be referred to collectively as the *basal ganglia*.

Elementary structure of the nervous system. — The

from the

FIG. 5. Various types of neurones, showing cell bodies of various shapes and sizes, together with their branching processes. (From Angell, by permission of Henry Holt and Company.)

nervous system, like other parts of the body, is composed of cells. The nerve-cell, or neurone (Fig. 5), however, differs from other cells by having attached to the main cell-body thread-like branching fibers which extend from it in various directions. Some of these

FIG. 6. Showing the synaptic connections between neurones and the complicated relations arising from such connections. (Modified from Judd.)

fibers are extremely short, while others are several feet long. The nerves shown in Fig. 4 are composed of many of these longer fibers bundled together, each fiber in the bundle being a part of a different neurone.

The synapse. — No neurone acts independently: it always acts in conjunction with other neurones. The fibers end in very fine branches, and the branches of

fibers belonging to one neurone come into contact with the branching fibers of other neurones (Fig. 6). The point of contact is known as the synapse. The fibers do not grow together at this point, but merely interlace one another. The neurones, by virtue of these connections, form systems of greater or less complexity. In any given action of the nervous system, therefore, more than one neurone is concerned.

The sensori-motor arc. — The entire path of a nervous impulse (consisting of a system of interconnected neurones) is sometimes referred to as a sensori-motor path or arc. It is called sensory because it has its origin in a sense-organ (eye, ear, skin, and so forth). It is called motor because it ends in a muscle and is concerned in the movement of the muscle. The hyphen indicates that the entire structure from beginning to end is in reality one mechanism and functions in a unitary way.

Gray matter. — In many parts of the nervous system the cell-bodies are grouped closely together, giving these parts a characteristic grayish appearance. Such fibers as are present here are very short, so that the bulk of the material is composed of cell-bodies. Gray matter is found especially in the outside portion of the cerebrum (known as the cortex) and in the inside portion of the spinal cord. The cortex in the human cerebrum, although only an eighth to a quarter of an inch thick, is extremely complex, as shown in Fig. 7.

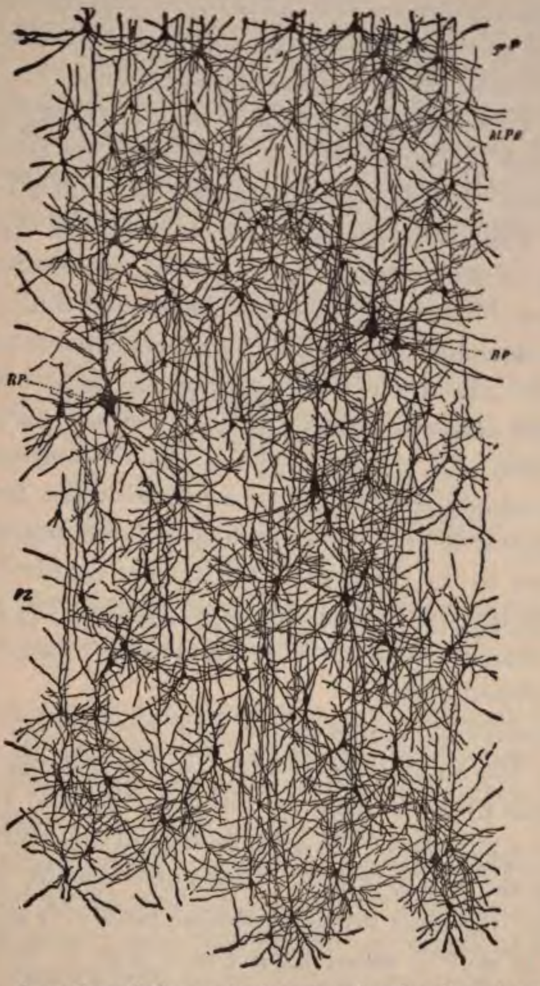

FIG. 7. A section of the cerebral cortex showing its extreme complexity. (From Thorndike's Psychology, by permission of the author.)

White matter. — The fibers of the various neurones also are grouped together to a large extent, and make up the white matter of the nervous system. The white matter forms the greater bulk of both the cerebrum and the other structures in the brain that lie below the cerebrum. It forms also the outer portion of the spinal cord. The nerves shown in Fig. 4, as well as the white matter of the central nervous system, are composed of bundles of fibers. It must be remembered that no fiber is ever detached, but each forms a part of some neurone the cell-body of which lies more or less distant from it.

Types of sensori-motor arcs. — For the purpose of our study the nervous system may be regarded as being made up of two types of sensori-motor arcs: (1) a relatively simple type in which nervous impulses do not pass to the cerebral cortex but are confined to the level of the spinal cord and basal ganglia; (2) a much more complex type in which the impulses pass through the cerebral cortex.

Sensori-motor arcs of the first level. — Let us examine the simple type first. This may most readily be done by a reference to the structure and function of the spinal cord. A cross-section of the spinal cord is represented in Fig. 8. The outer portion is white matter; the inner butterfly-shaped portion is gray matter. It will be noted from Fig. 4 that at various intervals nerves run into the spinal cord. The nerves, as we have seen, are composed of fibers. Some of the fibers are connected with the sensitive portions of the

skin; others are connected with the muscles. The fibers connected with sensitive parts of the body are known as sensory fibers; those connected with the muscles are known as motor fibers. Both sensory and motor fibers from the same general region of the body are bundled together and pass to the spinal cord in the form of nerves. All of the sensory fibers pass to

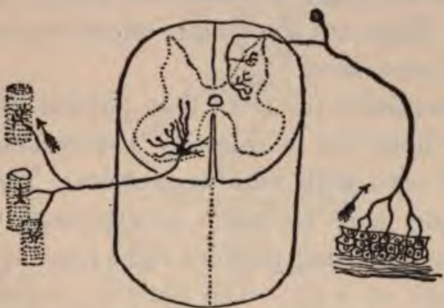

FIG. 8. Cross section of spinal cord. The nervous impulse is represented by the arrows as passing from a sensory surface of the skin across the gray matter of the cord to the muscles at the right.

the back of the spinal cord and enter the gray matter there on either the right or the left of the cord. The motor fibers enter the front of the gray matter of the cord either to the right or the left.

Neurones constituting the gray matter between the front and the back of the cord serve to bring the motor and the sensory neurones together by means of synaptic connections with each. Hence numerous complete sensori-motor paths are made, beginning in some sensitive portion of the skin, and continuing by a sensory

fiber to the gray matter at the back of the cord, thence through the gray matter of the cord to the motor fiber at the front part of the cord, and thence to some muscle. Sometimes the connection is made between sensory and motor neurones on the same side of the body —sometimes on the opposite side. Again, sometimes the connection is made at a point higher up or lower down than the point at which the sensory fiber enters the cord. These are the simple sensori-motor paths of the spinal-cord level.

Every sensitive point of that portion of the body below the head has in this way a connection through the spinal cord with various muscles. The diagram, for example, may be taken to represent what happens when a sleeping person's right hand is tickled by the presence of a fly. The nervous impulse aroused finds its way by the course marked by the arrows back to the muscles of the other hand, and the movement of brushing away follows almost immediately. Such movements are known as reflex actions.

The special senses in the head are not connected with the spinal cord, but send their nerves directly to the structures at the base of the brain which we have called the basal ganglia. Here they find connections with motor neurones in a similar way to that which we have described as taking place in the spinal cord. Reflexes, like those of the opening and closing of the pupil of the eye in response to the amount of light, are brought about in this way.

Higher conduction paths. — One essential function of the spinal cord and basal ganglia has not been considered up to this point. The white matter of these structures contains many fibers that pass upward to

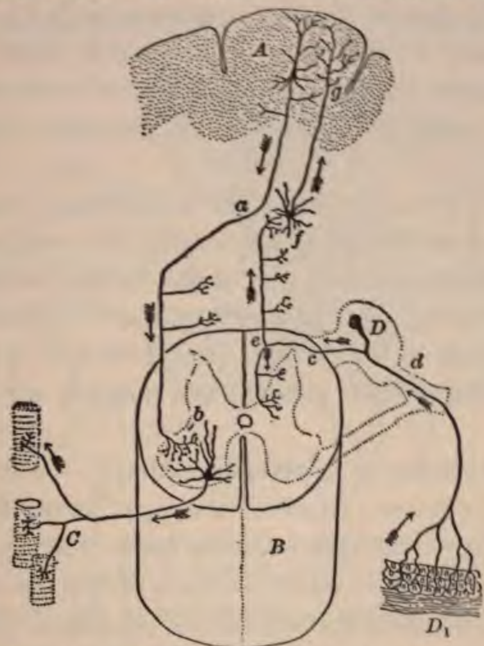

FIG. 9. Showing the path of impulses reaching the cortical level. D_1. Sensory portion of skin. D. Sensory nerve cell body. C. Muscles. A. Cerebral cortex. (After Cajal.)

the cerebral cortex, as shown in Fig. 9. By means of these every sensitive portion of the body has connection with some part of the cerebral cortex. A nervous impulse originating in the foot, for example, may in some instances be deflected from the immediate path

to the muscles through the cord, and may take a roundabout path through the cerebral cortex. When the neural impulse takes this longer path it follows a sensori-motor arc of one of the higher levels. Most of the fibers that pass to the cortex cross over from one side of the body to the other somewhere in their course, thus bringing the left hemisphere into functional relationship with the right side of the body, and *vice versa.*

Neither the sensory nor the motor fibers that reach the cortex are scattered confusedly, but each group of fibers belonging to any one of the various senses, *e. g.*, vision, hearing, and so forth, passes to definitely localized areas in the cortex. It will be well to indicate the position of these areas at this point in our description.

Sensory areas of the cerebral cortex.— Fig. 10 represents the outer surface of the right hemisphere, the front lying to the right and the back lying to the left of the page. The entire surface of the cerebrum is covered with folds or convolutions, so that if spread flat it would occupy about thirteen times as much space as it actually covers. The fissures are still deeper clefts in the cerebral structure, and those of Sylvius and Rolando will aid us in locating the various areas.

It will be seen from the figure that an area near the back part of the cerebrum is the visual area; that is, all of the sensory fibers reaching the cerebral cortex that are connected with vision are functionally related

to the cell-bodies in this area. A similar area receiving the auditory sensory impulses is found in the temporal region of the brain below the fissure of Sylvius. The sensory areas for smell and taste are on the inner side of the cerebral hemisphere, and hence cannot be

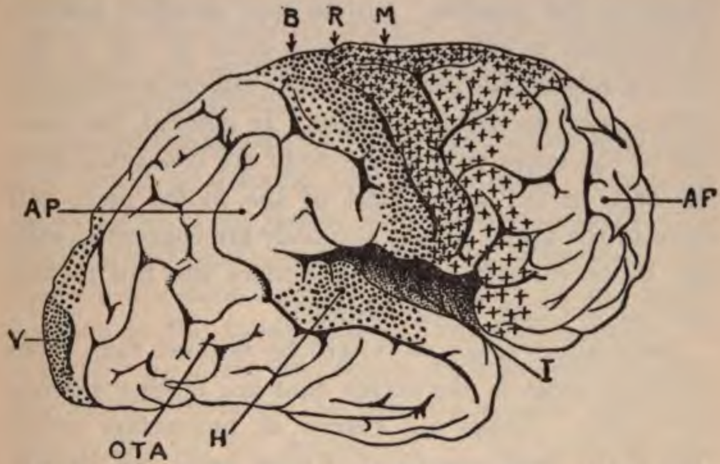

FIG. 10. Exterior aspect of right hemisphere of cerebral cortex. V. Visual sensory area. H. Auditory sensory area. B. Sensory area for touch, etc. M. Motor area. A.P. Association area. O.T.A. Association area. A.F. Association area. I. Association area disclosed to view by separating Fissure of Sylvius. R. Fissure of Rolando. (Modified from Angell after Flechsig.)

shown in this figure. The important area just behind the fissure of Rolando is the sensory area for the senses whose end organs are in the skin and muscles (touch, temperature, and muscular senses). The visual, auditory, and touch areas also overlap on the inner surface to a certain extent.

Motor areas. — Besides these sensory areas there

are other areas in the cortex, which may be described as motor. The motor areas occupy a position immediately in front of the fissure of Rolando. These are the areas from which the motor fibers pass on their way to the lower parts of the brain and spinal cord and thence to the muscles. Just as each sensitive portion of the body is represented by a point in one of the sensory areas of the cortex, so every muscle is connected with a point in this motor area. In general, the muscles of the lower part of the body are connected with the cells in the upper part of the motor area, and those of the upper part of the body are connected with the lower centers, with the centers for the middle part of the body lying between.

Association areas. — It will be noticed that there are large areas in the cortex that are neither sensory nor motor. These are known as association areas. One of the most important of these areas lies directly in front of the cerebrum, and is known as the frontal association area. Another is in the general region between the auditory and visual areas, and is known as the parietal association area. The association areas are those portions of the cerebral cortex in which the various sensory impulses combine on their way to the motor area. In this way, provision is made for sensory impulses of various kinds to issue in a single movement, because they have become united in the association areas before passing onward to the motor areas. To take a simple example, the nervous impulses

aroused by simultaneously seeing and touching a book, after having arrived at their respective sensory areas, become combined in the association areas, and any activity that may result comes from the combined action of the two groups of impulses. On a subsequent occasion either the visual or the tactual stimulus alone might arouse a nervous impulse, which would follow the same path through the association areas and have similar motor results.

Sensori-motor arcs of the higher level. — We are now ready to describe the entire course of sensori-motor paths of the higher level. These paths at their origin are identical with those of the lower level, and pass by the same neurones as do they to the spinal cord or to the basal ganglia. Instead, however, of coming into direct connection in these regions with the motor neurones, the nervous impulse follows a longer path up the spinal cord or the basal ganglia, or both, to the appropriate area in the cerebral cortex. From this point the nervous impulse passes to the motor area by way of an association area. From the motor area the impulse passes downward to the muscles that are to respond to the stimulus. The lower portion of the motor path is, therefore, also identical with that of the lower-level arcs. The sensori-motor arcs of the higher level are thus built on the plan of a loop on those of the lower level.

Sensori-motor arcs of an intermediate level.— While the two levels of sensori-motor arcs that have

been described give a general idea of the nervous system in its functioning, many details are omitted. There is reason to believe, for example, that a system of sensori-motor arcs exists intermediate between those of the two levels already described. It is known that there is a relatively small number of motor cells in and around some of the sensory areas in the cortex, especially the areas for vision and touch. Some impulses that have reached the sensory areas, therefore, find their way back to the muscles without going through the association areas. When this happens the resulting action is of the kind known as sensation reflexes. Examples of sensation reflexes are sneezing, coughing, turning of the head and eyes in the direction of flashes of light. Such actions are accompanied by vague consciousness of the stimulating object, but follow the stimulus immediately in a similar manner to the reflexes of the lower level.

If we add this type of sensori-motor arc to our list, the entire nervous system may be represented by the accompanying diagram (Fig. 11), each level of arcs being represented by a loop on the one next below it. The lowest level is relatively simple and consists of few neurones; the action resulting is direct and has no connection with consciousness. The third-level arcs, on the other hand, are very complex, involve many neurones, and the action is delayed and fully conscious. The second-level arcs occupy an intermediate position in all these respects.

Brain weight and intelligence. — The characteristic accompaniment of consciousness belongs, as far as we know, only to the functioning of those sensori-motor

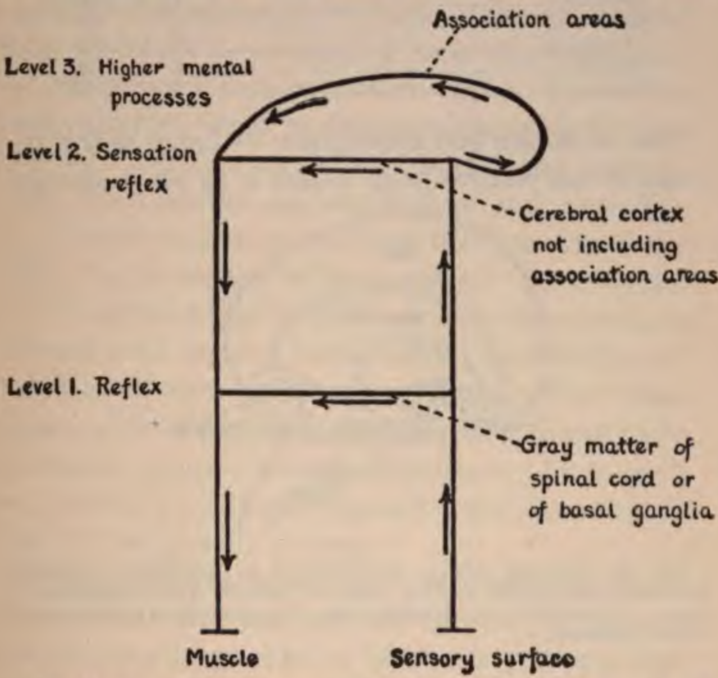

FIG. 11. Schematic representation of nervous system regarded as made up of three levels of sensori-motor arcs.

paths of the higher levels, which reach the cerebrum, and this fact is what gives the brain its significance as the organ of intelligence. In the course of animal development the brain becomes increasingly heavier as intelligence increases. The following table shows

the increase in brain weight relatively to bodily weight among the vertebrates, from fishes to man:

Fishes	1	:	5,000
Reptiles	1	:	1,500
Birds	1	:	220
Mammals	1	:	180
Ourang	1	:	120
Man	1	:	50

The cerebrum and intelligence. — Large as this increase in the relative brain weight is as we go upward

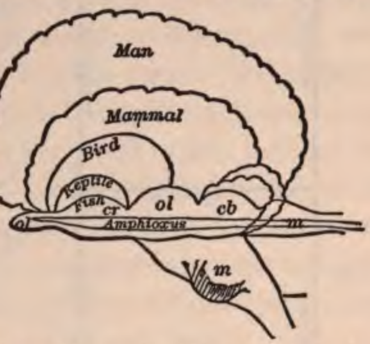

Fig. 12. Showing relative development of fore-brain, mid-brain and hind-brain in the various orders of animals from amphioxus to man. *cr*, cerebrum; *ol*, olfactory lobe; *cb*, cerebellum; *m*, medulla. (After Leconte.)

in the scale of animal evolution, there is even a more marked increase in the size of the cerebrum as compared with that of the rest of the brain. Fig. 12 shows to what an extent this is true, and especially in the case of man. The true significance of the relatively large cerebral hemispheres in man may be understood by a comparison of the way in which the higher and lower sensori-motor arcs begin to function. The latter

are capable of functioning as soon as the animal is born, or soon afterward. They represent fixed modes of action that have been inherited by the animal as a part of his nervous structure. The sensory and motor neurones are *organized* from the beginning; that is, they act as a connected whole. They bring about activities which in the long history of the race have been useful in a relatively unchanging environment. Such actions are usually fixed and invariable. The cerebral centers, on the other hand, are extremely plastic, that is, capable of being molded. They contain many neurones whose connections with other neurones have not been made at birth, making possible the organization of new sensori-motor paths. What these paths shall be depends not so much upon the animal's inheritance as upon his own experience. In a word, the cerebral hemispheres represent the physiological basis for the learning process.

Meaning of infancy. — It is an interesting fact that those animals that can perform at birth, or shortly afterward, the larger number of all the activities that their life conditions make it necessary for them to perform, attain a comparatively low grade of intelligence. Their actions are comparatively fixed and invariable, and they have little power of learning. On the other hand, the relatively large amount of plastic material in man's cerebral hemispheres makes the organization of new paths not only possible, but necessary, if his behavior is to be intelligent rather than

merely instinctive. The long period of infancy in man is thus a period during which education becomes a virtual necessity.

Compare, for example, the life history of such an animal as the chick with that of man in this respect. The chick, shortly after being hatched, can do practically all that the mother hen can do. It is not dependent for a long period, as is the child, upon its parents; the period of its infancy is very short. The long period of infancy of the child, however, gives him a great advantage over the chick in what he is eventually able to do. The chick learns to do little or nothing new and has a narrow range of possibilities. The child's inborn organized responses are merely the beginning points for innumerable activities suitable to cope with the varied nature of his future environment.

Physical basis of intelligence. — While it is true, as has been stated, that in the order of development there is general relationship of correspondence between intelligence and the size and weight of the brain, one cannot rightly conclude that the intelligence is dependent upon these factors in individual cases, although it is probable that, on the average, more intelligent persons have heavier brains than those who are less intelligent. Many other factors, such as complexity, quality of the finer nervous elements, must enter into consideration; and even in these respects it is not possible with our present knowledge to say exactly what these physical bases of mental capacity are. Doubtless pure and

abundant blood supply is of great importance in this connection; for the neurone, like all other cells of the body, derives its energy and power of growth from the blood. This factor of brain development, fortunately, may be controlled to a large extent by proper nourishment and exercise.

Brain development. — The number of neurones, or nervous elements, in a person's body is fixed at birth and does not increase in later life. The development that takes place consists simply in an increase in the size and complexity of those neurones already present, and in the forming of new connections between the various neurones. Many of the neurones, especially those in the cerebral cortex, are at birth imperfect, because they lack certain protective tissues that are essential to their functioning. The increase of the brain in size and weight practically ceases at about the age of eight or nine years.

The purpose of education is to control behavior. — One especially important aspect of the nervous system in its relation to education remains to be emphasized. Our study of the nervous system has shown that it exists for the especial purpose of bringing about muscular activity. Wherever nervous impulses occur they are found to pass over sensori-motor arcs to muscles, and to result in changes of behavior, using this term in its widest possible meaning. Some of these sensori-motor arcs function without the intervention of consciousness. Others, of a higher level, are accom-

panied by consciousness when the nervous impulse traverses them. In all cases, however, the ultimate goal of the process is its transformation into muscular activity. Even consciousness, therefore, seems to exist not so much for its own sake as for it relationship to behavior. Such considerations tend to put the emphasis in education on training the child to useful and correct modes of response rather than on the acquiring of a fund of knowledge. This point of view has been splendidly brought out by James in his "Talks to Teachers" in the following statement:

> Man is an organism for reacting on impressions; his mind is there to help determine his reactions, and the purpose of his education is to make them numerous and perfect. Our education means, in short, little more than a mass of possibilities of reaction, acquired at home, at school, or in the training of affairs. The teacher's task is that of supervising the acquiring process.

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CHAPTER III

BEHAVIOR—NATIVE AND ACQUIRED

Unlearned activities. — The relation that consciousness has to action may perhaps be seen best by a consideration of behavior that is relatively unconscious. All animals are born capable of performing certain activities, and as they grow older the number of these unlearned activities increases. The vital processes of breathing, digestion, and circulation of the blood are present at birth, and continue without any necessity of conscious control. From the outset the child responds to contact with the lips by the sucking movement. These and many other activities that the child performs without having to learn them are clearly the means that nature has taken to insure his survival.

Physical basis of unlearned activities. — Since muscles are never active except as stimulated to action by the nervous system, we must look for the explanation of these unlearned activities in the condition of the nervous system. The nervous mechanisms for performing those activities that are present at birth must be there from the beginning, ready to do their work. Nervous mechanisms ready to function are *organized* sensori-motor arcs. By an organized sensori-motor

path is meant one in which the parts (that is, the neurones) are so thoroughly connected that they work together as a unit. The synapses that form the connections between neurones offer varying degrees of resistance to the neural impulse. If the resistance is great, so that the impulse cannot pass readily from one neurone to another, the sensori-motor arc is to that degree unorganized. In the case of those sensori-motor arcs that are the mechanism for bringing about unlearned activities, on the other hand, the synaptic connections offer little or no resistance to the nervous current, because they are inherited in that form.

Consciousness and organization. — In general, it may be said that the better organized is the neural mechanism for bringing about any activity, the less conscious is its performance. Activities that do not have to be learned are made relatively unconsciously. This does not mean that no consciousness whatever attends the functioning of well-organized sensori-motor arcs; but the activities that result are not initiated and guided by consciousness, as seems to be true of other classes of movements. The consciousness that accompanies them is usually a consciousness of the movements having been performed rather than of their being about to be performed. The action seems to take place of itself, and is then reported to consciousness. It is for this reason that this class of actions is often called *involuntary*.

Automatic activities. — Unlearned activities may be classified as *automatic, reflex,* and *instinctive,* although no hard and fast line may be drawn between them. Automatic movements consist of the internal activities, like those of breathing, circulation, and digestion, which are present from birth and continue without conscious direction throughout our lives. The organized sensori-motor arcs controlling the action of the heart, lungs, and glands are aroused to action by changes within the body itself. Nature has provided that these processes should go on independently of consciousness because of their fundamental importance to life.

Reflex activities. — Reflex actions are simple activities following directly upon external stimulation. While the sensory excitation for automatic movements comes from within the body, that for reflexes comes from without. The reflexes include such activities as sneezing, coughing, the involuntary winking of the eye when an object approaches it, the expansion and contraction of the pupil of the eye with the changing intensity of light, etc. Movements that are usually automatic or reflex may sometimes be controlled consciously, as when the breathing movements are checked or made faster, or when the eye is winked voluntarily. In these cases the movements are brought about by higher level sensori-motor arcs than those used when the movements are not consciously controlled. The reflex and automatic activities are, however, little sub-

ject to modification, being fixed responses to fixed conditions. They are, therefore, of relatively little importance for education.

Instinctive activities. — The largest and most important class of actions that are made without learning is the instinctive. While these are difficult to distinguish from the reflexes, they are in general more complex and require a longer time for their performance. Furthermore, they involve such a large amount of purposefulness and are so adequate for the life conditions of the organism as to give the impression that they are guided by intelligence. Nevertheless, it is certain that these instinctive activities are as truly the result of inherited nervous structure as are the simpler reflex and automatic movements.

The instincts are found in pure form among the lower animals to a much greater degree than in man, it being agreed by the closest animal observers that most of their activity is of instinctive origin and remains so. Some of the instincts of the lower animals, such as, for example, ants and bees, have been studied in great detail. The way in which ants and bees return to their nests after wandering from them a long distance is a matter that awakens our wonder. It has been shown, however, that these animals are not able to change their route when even very slight changes are made in their environment. When a bee's nest is turned slightly around, for example, it is unable to find the entrance.

This illustration shows one of the most striking characteristics of instincts, namely, their *invariableness*. Instinctive behavior is suited only for relatively fixed conditions. A careful observer of animal behavior has made the remark that "instinct is that on which you can safely bet." Animals of a certain species perform their activities in practically the same manner, and without having to learn them. Bees, for example, go through the process of swarming, making cells, depositing eggs, etc., all without previous training. Birds of a certain species build their nests in a certain way and in a certain place, and the manner and place do not vary to any great extent.

Even in the lower animals, however, instinct is frequently subject to some modification, so that the action loses its purely instinctive character. Whenever an animal performs an action instinctively for the first time, the action is blind; that is, there is no knowledge of the result or the end of the act. But in an animal that has memory the subsequent performance of this act will be in some degree intelligent; the animal will know in advance the end of the action, and its behavior may be modified accordingly. In the case of human beings, therefore, little of adult behavior can be regarded as purely instinctive. The modification of the child's instinctive actions so as to make them suited to our educational ideals is an important function of education. The instincts are the stock in trade with which the child begins his commerce with the world and

which the educator may use as a basis for future behavior.

Deferred instincts. —The nervous mechanisms for bringing about instinctive reactions are not ready in all cases to function at birth. Each instinct has its time for maturing, and in man a number of the instincts do not appear in full strength until quite late in life, as is the case with the sexual instinct. It is important for those who have charge of the training of the young to watch for the appearance of the various instinctive tendencies. If these instincts are useful forms of response under the conditions of modern society, they should be encouraged; if not, they should be suppressed or modified.

Waxing and waning of instincts. —Many attempts have been made to discover the order in which the various instincts mature, and to determine the ages at which they make their appearance. These attempts have been largely unsuccessful. Since the instincts are so much subject to modification, it is almost impossible to separate the learned from the unlearned activities. The time of appearance and order of development of instinct is in part determined by the varying circumstances of the lives of different individuals.

The instinctive fear of dogs, for example, will be present in the life of one child at an age when another has never been placed in a situation to call it forth. On the other hand, it may apparently never be present if the circumstances are so favorable that it is modified

from the beginning. Great differences must be expected, therefore, in the time at which instinctive tendencies manifest themselves. Sometimes they seem to appear and disappear suddenly. At other times they gradually wax and wane.

Ways in which instincts become modified. — An instinctive reaction may often be suppressed or modified if the conditions are not present to encourage it when it first makes its appearance. In dogs the instinctive activity of burying bones has been known to be suppressed simply by keeping the animal indoors where the scratching movements find no encouragement. In such cases the scratching may go on for a few days, but will eventually cease and probably never appear again. Disuse cannot, however, always be counted on to be effective, especially when the instinct is very strong. In other cases the conditions may be such as merely to modify the instinct rather than to suppress it entirely. Lloyd Morgan has described how chickens that were hatched in an incubator followed him in the same manner as they would have followed the hen, had there been one present. The instinct fastens itself to the most suitable stimulus present at the time of its maturing, and continues in this form. Providing a substitute stimulus for the natural one, in those cases where the instinctive tendency in its original form is undesirable, is in many instances the best method of dealing with the instinctive tendencies of children.

Modification of instincts by means of their effects.

— It is a fundamental law of the mental life that any activity that has pleasurable results tends to be repeated, while one that has unpleasant consequences will be repressed. This law holds not only when the agreeableness or disagreeableness of the action is its direct effect, but also when it comes as an indirect result. For example, dogs undoubtedly derive instinctive satisfaction from barking at passing vehicles; but if a dog is whipped each time the barking takes place, the disagreeable results of the whipping are so strongly associated with the whole situation that usually the barking may be suppressed in this way. Instinctive tendencies, may, therefore, be suppressed by associating them with disagreeable results, or they may be encouraged by associating them with experiences from which pleasure is derived.

Modification of instincts inevitable. — Since instinctive actions are a part of man's inherited equipment for successfully meeting life's demands, it may be questioned whether it is wise to seek to modify instinctive behavior in the young. Educational writers like Rousseau, who urge us to follow nature in education, seem to imply that the child should be allowed to follow the natural instinctive tendencies without hampering or attempt at modification. It must be remembered, however, that it is not only natural for man to act instinctively, but it is also natural and inevitable for him to modify his instinctive behavior. It becomes, then, a question of whether the child's original instinc-

tive nature should be changed as a result of haphazard experiences, or whether the adult should undertake the responsibility of selecting for the child the experiences deemed the best for his development. Unless the latter is done, all purposeful education must be abandoned.

On the other hand, it is easy to make the mistake of attempting to ignore or utterly repress the child's instinctive nature. If instincts are not always right, as Rousseau seems to imply, it is also true that they are not inherently wrong. Man has set for himself standards of action which require that he shall not live on a purely instinctive level. In so far as the instincts conflict with these standards they need to be modified, but the instincts themselves could not be ignored even if it were desirable.

List of human instincts. — The number of instinctive responses in human beings is not small, though, as we have seen, they are less likely to remain purely instinctive than in the case of the lower animals. Among the most important of human instincts are fear, anger, curiosity, manipulation, play, imitation, constructiveness, ownership, rivalry, fighting, food-getting, gregariousness and the sexual instinct. Some of these, which are of especial interest and importance in regard to education, will be described in the following paragraphs.

Fear. — Fear and curiosity are two opposed instinctive tendencies of a fundamental kind. The tendency to move toward what may be of advantage, and the

tendency to move away from what is harmful, are present in the lowest species of animals. In man these reactions take many different forms and may be accompanied by very complex forms of emotional consciousness. Purely instinctive fear is likely to make its appearance in children in connection with loud and sudden noises, darkness, solitude, strange and unfamiliar objects, especially furry animals. The fear of falling and the fear of high places are also very common. In many children these fears are clearly of instinctive origin and not due to unpleasant experiences. Frequently, however, the fears of young children are due to painful experiences of their own, or are suggested through imitation of others, especially parents. Among the most marked motor effects of fear are changes in the rate of breathing and of the heart-beat; running away; remaining in a tense attitude without moving and crying out. Many fears, especially in younger children, need kind and sympathetic treatment from parent and teacher. Fear of dogs, for example, in a child may be so strong as to make life miserable, and often time alone and a gradually increasing familiarity will suffice to rid the child of this bugaboo. Shyness is a form of fear that occurs frequently in younger children, and one that, even under encouraging treatment, frequently needs a long time to overcome.

To what extent fear should be used as a motive in the training of children is a question of moment, the pros and cons of which have been much debated. It

is clear that the appeal to fear of punishment, especially of physical pain, does not furnish a high motive for action. On the other hand, the fundamental character of such appeals makes them frequently successful where higher motives fail, and when judiciously used fear may become one of the most useful sources of training. It may be questioned whether absolute fearlessness is a desirable characteristic in any individual. That sort of refined fear which consists in respect for duly constituted authority may easily be undervalued.

Curiosity. — Curiosity is an expression of a tendency quite the opposite of fear. Whereas fear leads to withdrawal from that which is feared, curiosity prompts action toward the object concerned. Even in those cases where the object of the person's curiosity is not external but of an intellectual sort, the attitude is the same, that is, one of seeking rather than of shunning. The strength of this instinct, especially in children, is very great. It begins perhaps in the fixed stare of the infant a few months of age, and continues in the ceaseless activity and questioning of a later stage. A frequent form in which curiosity manifests itself is destructiveness, where the motive is to discover how things are made and how they work. At a still later period this instinct may take the form of desire to travel and to read books of travel. Even some cases of truancy may be regarded as due to a sort of migratory instinct, at the basis of which is the desire to see and hear what is new. To keep alive the questioning atti-

tude of the child along lines that are of intellectual value is one of the great tasks of the educator. Children's problems and questions should be sympathetically treated, and especially should the spirit of intellectual inquiry be fostered rather than stifled by appeals to authority; for perhaps no other characteristic is so indicative of a person's intellectual promise as his desire to know.

Imitation. — Imitation, play, and constructiveness are closely allied activities of great importance to human life and progress. Imitation is one form in which a very fundamental psychological law finds its expression. It has already been frequently emphasized that movements are the normal accompaniments of all our conscious processes. When the conscious process is itself the perception of a movement or the idea of a movement, the tendency to perform a similar movement is especially marked. The imitation of their elders by children, together with the transmission of ideas through language, which is itself handed down from one generation to another through imitation, makes for permanence and progress in institutions and customs. The lower animals, having practically no capacity for either language or imitation, are deprived of these means of progress.

The purely instinctive forms of imitation are probably fewer than ordinarily supposed, as Thorndike has shown, though a limited number of such activities are present from the beginning of life. Babies a few weeks

old, for example, will smile in response to a smile. It must not be supposed that such imitation is in any sense consciously directed. The activity comes spontaneously, as when a person yawns and the person who observes him does the same. The first words spoken by the child are also probably quite largely the result of spontaneous imitation.

The spontaneous form of imitation rapidly transforms itself into a voluntary form when the imitator purposely executes a movement similar to that which he has observed. The more developed form of imitation, however, cannot be entirely separated from the more purely instinctive form. The tendency for an observed act to result spontaneously in a similar act is always present, and its effect is to prompt the process of learning. In imitating others, not only does the child learn to act in new ways, but he learns to appreciate how other people feel and what they are striving for in their activity. Imitation is thus a source of social appreciation. Children tend both consciously and unconsciously to imitate the speech and manners of older persons, especially those whom they most admire, making the personality of the teacher a matter of the utmost importance.

Play. — The value of the instinct of play in the mental development of the young cannot be emphasized too much. Play finds favorable conditions for its expression in the surplus energy characteristic of youth, but it often appears, especially among adults, as a

means of recuperation from fatigue. The true significance of instinctive play may perhaps be seen best, however, by considering the play of the lower animals. Most of the lower animals develop forms of play that are characteristic of the species to which the animals belong. It would seem that these playful activities are definitely related to the adult activities of the same species of animal. The play of the kitten may be taken as an example of this fact. It has been pointed out that the play of the kitten brings into play the very activities that are used in its later life as a mouse-catcher. From this point of view, play is a preparation during the leisure of the young for the serious activities of later life. That this is true in the life of the child need hardly be pointed out in detail. Through play more than anything else the child learns to know the world of objects around him, and how to use them. In play, too, the child's imagination and ideational activity are continually being brought into use, and thus his thinking faculty is developed. Children engage in forms of play, like the running and jumping and ball games, that are remarkably similar in all races. Such play is especially effective in the training of the body and in physical development. Many forms of play, on the other hand, are peculiar to a particular race or environment, and are imitative of adult pursuits. From this point of view, play must be regarded as a preparation for the serious activities of later life during the leisure period of youth.

Stages of development of play. — Ordinary observation of children's play shows that it takes different preferred forms at different ages. The baby is delighted with bright colors, loud and novel sounds, and other forms of sensory experience, especially when these experiences are associated with movements that he makes himself, as in the case of the rattle. Movements are repeated over and over again just for the sake of the pleasure they give. Witness the pleasure of the young child in repeatedly dropping a spoon, or in tearing or rustling a newspaper. In this way the baby learns to recognize his own body and the qualities of objects with which he comes into daily contact, as well as various ways of manipulating them. As he grows older he takes greater and greater interest in producing effects upon objects and in manipulating them. Children derive their enjoyment from playthings, for the most part, because of the possibility of doing something to them which produces a novel result. Toys are constructed on this principle. One other feature of the toy is that it frequently represents something with which a child is familiar but in a form that he can handle and "make go," as, for example, the toy horse. More and more as the child grows older manipulation takes the form of various kinds of building and construction. At the same time, imitation and imagination are giving rise to an emphasis on dramatic forms of play.

By the time the child reaches school age he feels a definite need for companionship in play, and through-

out the elementary school period a strongly competitive element is present, though at first the rivalry is between individuals. Toward the end of this period there begins to develop the interest in team competition in the case of boys and in clubs in the case of girls. Interest in intellectual forms of games makes its appearance also during this period. From the time of adolescence, team play, with its necessary accompaniments of leadership and coöperation, becomes predominant. Intellectual play also increases in importance from this time onward.

Constructiveness. — Play and imitation both find frequent expression in the activity of construction. Since this activity is present in adult life as a separate activity from play and imitation, and since it is also found among the lower animals, it may be regarded as a distinct instinctive tendency. In adult human life, however, its purely instinctive character is largely lost, while in the lower animals it is restricted to definite forms of structures, such as the nests of birds, or the hives and honeycomb of bees, or the dams and dwelling-places of beavers. The great importance of this instinct for mental development arises (1) from the increased efficiency that comes from the habits developed in the process of construction; (2) from the increased knowledge due to the accurate and precise observation of materials necessary for successful construction, and (3) from the encouragement of new ideas and the development of these ideas through making them definite

in the form of the constructed work. The value of constructive kinds of school work, like manual training in its various branches, drawing, etc., is therefore accuracy of muscular adjustment, the development of precise powers of observation, and the cultivation of a form of imagination that is being continually tested by the practical results.

Ownership.—The desire to collect and own things is clearly instinctive, both in many of the lower animals and in the child. But the form this instinct takes in the lower animals is largely restricted to the storing away of surplus food, while the child's desire for ownership may take many directions. Ownership becomes an incentive for work, and thus has a great effect on mental development. The instinct may be useful in the education of children if the child is encouraged to make collections that become the source of information, like the collection of stamps and scientific specimens. These collections may also readily be made the occasion for the teaching of the importance of neatness and order.

Rivalry. — Rivalry, or emulation, belongs to the class of instincts that is sometimes called individualistic. It is thus akin to the fighting instinct, and readily passes over into anger, hate, jealousy, and envy. For this reason the encouragement of rivalry is dangerous, tending as it does to cultivate feelings of exultation at the degradation of others. It may be questioned, however, whether man would ever reach as high a degree

of efficiency if this instinct were entirely suppressed, and whether ambition is ever entirely divorced from rivalry. In training the young, therefore, the problem becomes one of moderating and guiding this instinct, rather than one of complete suppression. In the schools group competition, for example, may be substituted for individual competition, and the child may also be taught to try to outdo his own former accomplishment. In both these cases the instinctive desire for successful accomplishment is appealed to with less danger of arousing feelings against others.

Acquired activities. — That part of the nervous system which is fixed or organized from the beginning rather than plastic (capable of being molded) is devoted to the production of these unlearned activities that have been described. These are, then, the forms of behavior that may be counted on as entering into the activities of all individuals, whatever their experience has been or may be. All other forms of fixed or organized behavior are learned during the course of the individual's own experience and are called habits. One of the most important facts about habits, as contrasted with the kinds of behavior that we have described as innate, is the part which consciousness plays in their formation. Practically all forms of consciousness are concerned in habit formation, and it therefore becomes necessary to describe these in detail. While, then, the remainder of our study will be devoted to the study of consciousness, it must not be supposed that

this study has no relationship to behavior. On the contrary, we shall be investigating the various ways in which consciousness enters into the process of habit formation, as well as into other forms of behavior. Before passing to this phase of our work, we shall consider some of the features that apply to habit in general, whatever forms of consciousness are concerned in its formation and operation.

Similarity between habits and instincts. — It is a well-known fact that fully formed habits are performed with little or no attention to their performance, so that the relation of consciousness to a fully formed habit is quite as negative as to the innate activities that have been described. Habitual activities differ from reflex and instinctive activities in their history rather than in their result. The physiological processes underlying habit are similar to those that explain the instinctive forms of behavior, namely, organized sensori-motor tracts in the nervous system. If we were able to describe the changes that take place in these tracts while the habit is being formed, we should have a complete explanation of habit as far as its physiological conditions are concerned.

There are two chief ways in which newly organized sensori-motor tracts may be formed in the central nervous system: (1) by the growing together of the branching processes of the neurones, so that new connections are made; (2) by a reduction in the resistance offered by the synapses which form the points of con-

nection between the various neurones of any sensori-motor path. There is evidence that the synapse is crossed by the nervous impulse more readily the more frequently it has been used. The more readily the nervous impulse traverses the entire sensori-motor tract, the better organized are the neurones that are included in that tract, and the more immediately and without thought the resulting action follows.

Repetition and attention in habit formation. — Any activity that is frequently repeated soon becomes fixed in accordance with the principle that has just been described. Now, under some circumstances, activities may be repeated in this manner without paying much attention to the process, and thus a habit is developed without much consciousness of the fact. A habit may be formed much more readily, however, if attention is focused on the activity to be attained, and the presence of attention may thus become to some extent a substitute for frequency of repetition. The former of these two methods of habit-formation is sometimes referred to as incidental learning. Some habitual actions may be safely left to take care of themselves because of the frequency with which opportunities present themselves for learning them. Others, and especially those that are difficult to learn, need a great deal of attention during the course of their development. In learning to spell, for example, words that are frequently met with, and that also follow the ordinary rules, are usually learned incidentally with read-

ing and with little conscious effort. On the other hand, those words that are difficult because they do not follow the usual phonetic rules, or because of rare occurrence, require that extra attention be given them in order that they may be spelled correctly.

The importance of the two factors of attention and repetition has been strongly emphasized in the two practical maxims which James gives for the forming of good moral habits and the breaking of bad ones:

> The first is that in the acquisition of a new habit or the leaving off of an old one we must take care to launch ourselves with as strong and decided an initiative as possible. . . .
>
> The second maxim is: Never suffer an exception to occur till the new habit is securely rooted in your life.

Advantages and disadvantages of habit. — Provided an activity is one that will be frequently required to be performed, it is advantageous to make it habitual; for it will then be performed with greater ease, greater speed, and greater precision. Making activities habitual has the additional advantage of freeing consciousness so that it may be used in connection with the acquiring of other activities which have not yet become habitual, and which perhaps because of their nature should never become habits. For example, were it not for the fact that habits have been formed of making writing movements we should be unable to

concentrate our attention on the meaning of the words we wish to express.

While habit is in the main advantageous, one may become the slave of habit. Slavery to habit occurs when one is unable to change a certain form of behavior when there is good reason that one should do so. The reason for changing may be either that the habit is morally bad or practically inefficient, or that conditions have been so changed as to make change in behavior desirable. Persons who are not able to change their habits of thought or action when it would be advantageous to do so are not easily adaptable to new situations, and cannot readily change their opinions even though the evidence may require it.

In view of the tendency which everybody has to become more and more fixed in his habits as he becomes older, it becomes the more necessary that habits should be formed, when young, of such a kind as to be useful throughout life. The best time for the formation of useful, practical habits is probably the period from eight to twelve years in the child's life. This is the period for drill in all the processes that constitute the tools of learning, and that have to become automatic to be useful, such as reading, writing, and the fundamental processes of arithmetic. This is the time, too, for inculcating habits of correct manners, pronunciation (of one's own and foreign language), as well as habits involving moral qualities like cleanliness, independence, accuracy, honesty, and so forth.

The importance of forming good moral and intellectual habits has been emphasized by James in his well-known chapter on habit, from which the following striking quotation is taken:

> Could the young but realize how soon they will become mere walking bundles of habit, they would give more heed to their conduct while in the plastic state. We are spinning our own fates, good or evil, and never to be undone. Every smallest stroke of virtue or vice leaves its never so little scar. The drunken Rip Van Winkle in Jefferson's play excuses himself for every fresh dereliction by saying, "I won't count this time." Well, he may not count it and a kind Heaven may not count it; but it is being counted none the less. Down among his nerve cells and fibers the molecules are counting it, registering and storing it up to be used against him when the next temptation comes. Nothing we ever do is, in strict scientific literalness, wiped out. Of course this has its good side as well as its bad one. As we become permanent drunkards by so many separate drinks, so we become saints in the moral, and authorities and experts in the practical and scientific spheres, by so many separate acts and hours of work. Let no youth have any anxiety about the upshot of his education, whatever the line of it may be. If he keep faithfully busy each hour of the working day, he may safely leave the final result to itself. He can with perfect certainty count on waking up, some fine morning, to find himself one of the competent ones of his generation, in whatever pursuit he may have singled out.

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CHAPTER IV

SENSATION

HAVING surveyed the equipment with which man is endowed by birth for bringing about movements, and having seen in a general way how other activities grow up in the course of an individual's own experience, we shall now turn to a description of the detailed manner in which these new activities develop and their connection with the various kinds of conscious processes. The child is not born with ready-made activities to suit the greater number of objects and happenings in the world around him. It is true that he may react, as we have seen, in a limited number of ways to some of these objects and events. He responds, for example, in a perfectly definite way and with a perfectly definite set of activities to objects placed between his lips (the sucking instinct). Similarly, after a few days he turns his head in the direction of a bright light. But activities of this sort are relatively few in number and limited in their application. Accordingly, the child's immediate task is to learn to react to the objects in the external world about him, or, in other words, to develop a whole mass of habits in response to these objects. These habits arise in connection with

the conscious processes known as perception and sensation.

Objects in the environment act as stimuli to the sense-organs; that is, either by actual physical contact (as in touch and taste) or by means of physical vibrations (as in hearing and seeing), they produce changes in the sense-organs, and these in turn generate nervous energy in the nerves with which they are connected. This nervous energy, when carried to the appropriate sensory area in the cortex, becomes the condition for a consciousness of the qualities of these objects. The consciousness of the *qualities* of objects (including one's own body) thus brought about by direct stimulation of the sense-organs is called *sensation*.

In the early life of the child the objects around him must be continually stimulating his sense-organs and giving rise to sensations. These sensations at first throng into consciousness in a confused mass, and only gradually become distinguished from one another and grouped together in such a way as to mean certain objects. The consciousness of *objects* directly stimulating the sense-organs is known as *perception*. The process of perception is, of course, continued throughout adult life. During much of our waking life we are engaged in touching, hearing, seeing, tasting, smelling, etc., the objects about us and shaping our activities accordingly. Nor are we confined to the objects of our immediate environment, but through the senses

of hearing and sight we become conscious of objects far distant.

Sensations and perceptions occur together. — If we consider carefully the nature of any process of perception—for example, the perception of the book at which we are looking—we will observe that the process is not simple, but that it can be analyzed into still simpler processes. The book has certain qualities, especially those of color. If we care to examine the book by the sense of touch, we find that it has also touch qualities. The cover may be rough, the edges smooth. The perception of the book is bound up with a consciousness of its qualities. Perception and sensation, therefore, occur together and are different phases of one and the same process. Since sensation is the more elementary of these two related processes, we shall consider it first and deal with perception in the next chapter.

Visual sensations. — There are as many classes of sensations as there are kinds of sense-organs, and all of these will be briefly touched upon, beginning with visual sensations, since these make up so large a part of human adult perception. As has been seen, the stimulation of the sense-organs constitutes an essential condition of sensation. It will therefore be necessary for us to take into consideration the nature of the various sense-organs and the way they function. In order to make the description complete, the various sources of stimulation of the sense-organs must also be considered. The latter constitute the physical conditions of

sensations; the former, together with the changes in the nervous system, the physiological conditions.

The eye (Fig. 13) is similar to a photographic camera in its construction and in the way it does its work. The pupil, which is an opening in the iris (the colored

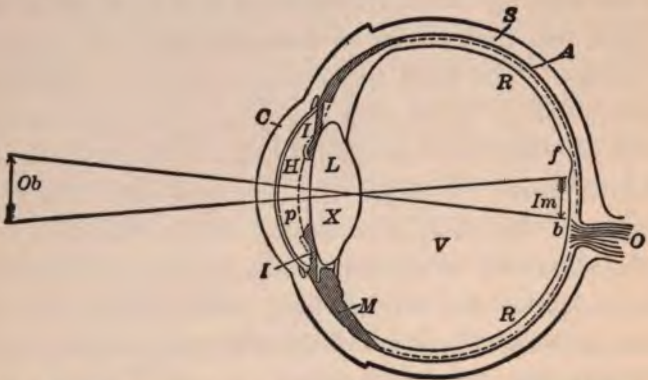

FIG. 13. Diagrammatic section of the human eye. *O*, optic nerve; *S*, sclerotic; *C*, cornea; *A*, choroid coat; *I*, iris; *R*. retina; *V*, vitreous humor; *H*, aqueous humor; *L*, crystalline lens; *X*, optic center of the lens; *b*, blind spot; *f*, fovea centralis; *p*, pupil; *M*, ciliary muscles, which control the curvature of the lens; *Ob*, object outside of eye; *Im*, image on the retina. (From Judd, after Wundt by permission of Ginn and Co.)

part of the eye), admits the rays of light. The expansion of the pupil in dull light and its contraction in bright light is analogous to the working of the diaphragm of the camera. In front of the pupil is the cornea, a transparent covering shaped like a watch-crystal. Just back of the pupil is the lens of the eye, which refracts the rays of light and brings them to a focus on the retina. Between the lens and the retina

is a mass of transparent jelly-like substance (the vitreous humor) which, with the aqueous humor in front of the lens, fills out the eye and gives it its shape.

The retina. — The retina is a thin film at the back of the eye. Although it is but one-hundredth of an inch thick, the microscope shows that it is extremely

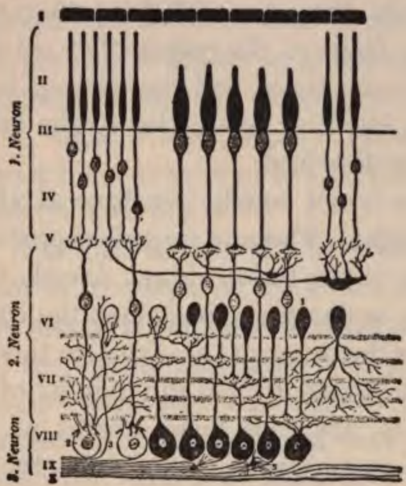

FIG. 14. Diagrammatic section of the retina. (From Judd, after Greef, by permission of Ginn and Company.)

complex. Fig. 14 shows the various layers of cells and fibers of which it is comprised. The layer marked X lies directly back of the vitreous humor. It consists of nerve fibers that are directly continuous with the optic nerve, the fibers of which in turn pass to the base of the brain and conduct the impulses to the visual area in the occipital region of the cerebral cortex. The layer of cells marked II is the so-called rod-and-

cone layer, which is connected with the fibers of layer No. X by a series of layers composed of interconnected cells (marked IX to III). It is this layer of rods and cones that is the true visual sense-organ, since it is here that the nervous excitation is set up which, when carried to the brain, is accompanied by the visual sensation. When the rays of light (ether waves) are brought to a focus on the retina, they set up changes in these rods and cones, and the nervous impulses result. These impulses are carried to the brain by the path already described.

The retina is not equally sensitive at all points to the rays of light. There is a small depression, known as the fovea, in the retina almost directly back of the lens. Under ordinary circumstances the eye is turned so as to bring the image of the object on this part of the retina, which is very rich in the number of highly developed cones, the rods being absent at this point. Outside this central point in the retina the number of cones decreases and the number of rods increases, until at the extreme edges of the retina the cones have practically disappeared and rods only remain. At one point on the side of the retina toward the nose, where the optic nerve enters the eye, neither rods nor cones are present. This point is known as the blind spot. An experiment proving that we are not able to see when the image strikes this part of the retina will be described later.

Muscular adjustments of the eye. — Just as the

camera needs to be adjusted or focused according to the distance of the object to be photographed, so the eye automatically adjusts itself so as to make a clear image of the object looked at on the retina. The adjustment in the eye is a muscular one by means of which the front surface of the lens is made flatter for distant objects and rounder for near objects. This adjustment of the lens is known as accommodation. In cases of near-sightedness and far-sightedness the eyes are unable to make this adjustment successfully, and artificial lenses have to be used to assist the eye in the process of accommodation.

Another muscular adjustment in connection with vision is that of convergence, by means of which the two eyes are moved inward and outward so as to bring an image of the objects upon the fovea of each retina. Both accommodation and convergence give rise to muscular sensations that become a part of the total consciousness when looking at objects.

Visual sensations and their stimuli. — There are, in general, two classes of visual sensations, namely, colored and colorless. The sensations of color consist of red, orange, yellow, green, blue, purple, and violet, both singly and in combination, and all their shades, tints, and degrees of purity. The colorless sensations consist of the series that begins with pure white and ends with black, innumerable shades of gray intervening. The members of this series differ from one another only in brightness.

The physical stimuli for visual sensations are ether vibrations. The eye is, however, sensitive only to those vibrations whose rates vary from four hundred and thirty-five trillions to seven hundred and sixty-nine trillions per second. Colorless sensations result from the mixture of waves of various frequency. Red is the result of waves of four hundred and thirty-five trillions per second; violet of waves of seven hundred and sixty-nine trillions per second; while the vibration rates of the other colors range between these two extremes.

The color series.— Certain relationships exist among the colors that enable us to arrange them in their spectral order—red, orange, yellow, green, blue, violet. This is the natural order in which to arrange colors when we are considering them from the physical point of view, red being the result of the slowest ether waves, and violet of the fastest, and the rates of vibrations of the other colors ranging between them in the order named.

It is an interesting fact, from a psychological point of view, that the relations between colors as sensations can better be expressed in a different manner from this straight-line series of the spectrum. If the colors are arranged in a circular fashion, as in Fig. 15, and purple included among their number, the arrangement will express very well many of the psychological relations between them. In this order of arrangement violet, instead of being farthest from red as in the spectral series, is brought close to it, and between them

is the transition color purple, bearing a relation to red and violet similar to that which orange bears to red and yellow.

Complementary colors. — Again, it will be noticed that in the circular order of the colors it is a bluish-green that is placed at opposite ends of the diameter from red, expressing the fact that blue-green is to be

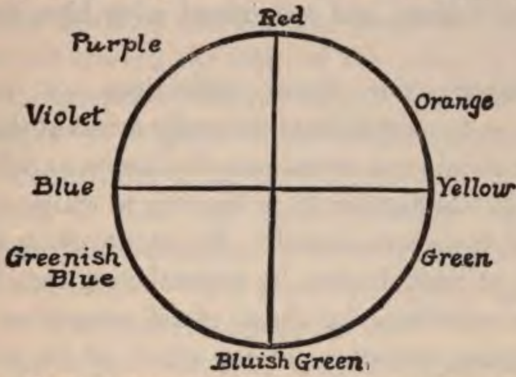

FIG. 15. Circular arrangement of colors representing complementary colors at opposite ends of diameters.

regarded as the color that is psychologically farthest away from red. The reason for this arrangement is that, from some points of view, red and blue-green are antagonistic colors. This may be seen from the phenomenon of color mixture. If these two colors be presented to the eye so rapidly that they stimulate the fovea at practically the same time, the retina cannot respond to both of them separately, and the two processes neutralize each other, the result being a sensation of gray. A simple method of mixing colors in this

way is to take two or more overlapping disks of different colors and rotate them by means of an electric motor. Two colors that when thus mixed produce a sensation of gray are called complementary colors. If a color is mixed with any color that stands nearer to it in the color circle than its complementary, the result is an intervening color. Thus red mixed with green produces yellow, and red mixed with blue produces purple.

Sensations not direct reflections of external events. — A question that naturally arises at this point is, Why should our sensations of color be so differently related to one another from the way in which colors as physical facts are related? We can explain the difference, at least in part, by remembering that the immediate condition for these visual sensations is not the physical vibrations of the ether, which make up the spectral series, but the effects these vibrations produce on the retina. Between the physical and the psychical realm stands the physiological.

Color-blindness. — The indirect character of the relationship between the physical and the conscious may be further emphasized by referring to the facts of color-blindness. All parts of the eye are not equally sensitive to color. If one eye is closed and the open eye looks at a fixed point, the image of this point falls on the fovea, or point of clearest vision. Now, if the eye is kept steadily fixated on the point and a colored object is brought in at the side, the part of the retina

stimulated is somewhere to the side of the fovea. Experimenting in this way shows that the retina may be divided into three parts, according to sensitivity to color. The first of these includes the fovea itself and an area around it where all colors are normally seen in their true color qualities. Farther from the fovea is another area where yellow and blue are seen in their true color qualities and red and green are not. Still farther out toward the edge of the retina is an area where the shapes of colored objects are seen but always appear to be gray. Even the normal eye is thus color-blind outside of the foveal region of the retina. The fovea is, then, the most developed portion of the retina for discrimination of color, and the edges the least developed, while the intermediate region is a region of intermediate development.

It would appear that gray is a more primitive visual sensation than any of the colors, and that yellow and blue are more primitive than red and green. This view is also supported by the fact that color-blind persons (that is, persons who are color-blind even in the fovea) are most frequently lacking in sensitivity to red and green, which are seen by them as either gray or some shade of yellow. It is rare that color-blind persons are insensitive to yellow and blue, and still more rare that all colors are seen as gray, although cases of both these kinds are found.

After-images.—When one looks at an object and then turns away from it, the effect on the retina re-

mains for a short time in the form of an after-sensation. Take a piece of colored paper, for example, and place it on a white background; then gaze at it for a moment or two. Now shift the gaze to another part of the paper. A patch of color of the same shape and size as the original colored paper will appear. The color of this patch will, however, be found to be the complementary of the original color, and the background immediately surrounding it will be dark gray instead of the original white background. These after-sensations are called negative because of the reversal of the color and of the light and shade.

Under certain circumstances, before the negative after-image sets in, a positive after-image is seen for a short time, which is of the same color as the original. On turning out a gas-flame suddenly, for example, the yellow flame may still be seen for an instant afterward, changing its position with the direction in which one looks. A moment later it is replaced by the negative after-image.

All of the above facts show that visual sensations are indirect and cannot be explained, except as the result of the physical stimuli producing certain physiological processes. The physical series differs from the psychical, and the latter are to be understood only by the interposition of the physiological series. This is universally true of all sensations, though not so strikingly marked in the other senses as in vision.

Recognition of color in children. — Children will

show a preference for colored objects over white and black as soon as they are able to grasp objects (at about six or seven months of age), and there is, therefore, a strong probability that ability to discriminate colors is present at that early age. It is at least certain that children, as soon as they are able to understand the instructions, can select colors like a given sample from a large number of other colors. Tests made in this way show that some children recognize red, orange, yellow, blue, violet, and purple early in the third year of life.

Ability to name colors with exactness, however, comes much later in development. Investigations made of children who are just beginning school have shown that about 30 per cent of the boys and 28 per cent of the girls could not name the four colors red, yellow, green, and blue correctly. Ability to note slight differences in saturation [1] increases rapidly during the school period, so that in this respect a fourteen-year-old child is two or three times as sensitive as a six-year-old child.

Whether the improvement that takes place in ability to recognize colors and differences in saturation during the school period is due to any development in the retina may well be doubted. Since color-blindness, which is probably due in most cases to lack of retinal development, cannot be overcome by practice, the im-

[1] A color is said to be more saturated the purer it is. Lack of purity is due to an admixture of gray. A fully saturated blue would be one that contains as much blue as is possible. The best examples of fully saturated colors are those of the spectrum.

provement is probably due to increased attention rather than to improved color sense; but the fact remains that the naming and recognizing of colors may be much refined by practice. The same point is illustrated by the superiority of women over men and of girls over boys in recognizing and naming colors, due to their greater interest and practice. It is interesting to note that children begin by preferring red to blue, but develop in the direction of preferring blue to red.

Auditory stimuli. — The usual source of sound in the physical world is vibrations of the air. These vibrations may be periodic, that is, occurring in regular succession, or they may be non-periodic, or irregular. In the former case they give rise to tone sensations, in the latter to noises. The more rapid are the vibrations giving rise to tone, the higher is the tone; the less rapid the vibrations, the lower is the tone. The greater the amplitude of the vibrations, the louder or more intense is the tone. The complexity of vibrations corresponds to the timbre of tones.

The ear. — The ear (Fig. 16) is composed of three parts, external, middle, and inner ears. The external ear-passage is separated from the middle ear by a membrane known as the tympanic or drum membrane. This membrane is attached on the inside to three small bones that stretch across the middle ear to the wall of the inner ear, where one of them, the stapes, fits into an opening in the wall of the inner ear. The inner ear consists of a series of winding passages so complex

as to have been given the name of the labyrinth. These passages of the labyrinth are filled with a liquid, which is set into vibration by the movements of the stapes, which has in turn been set in vibration by the

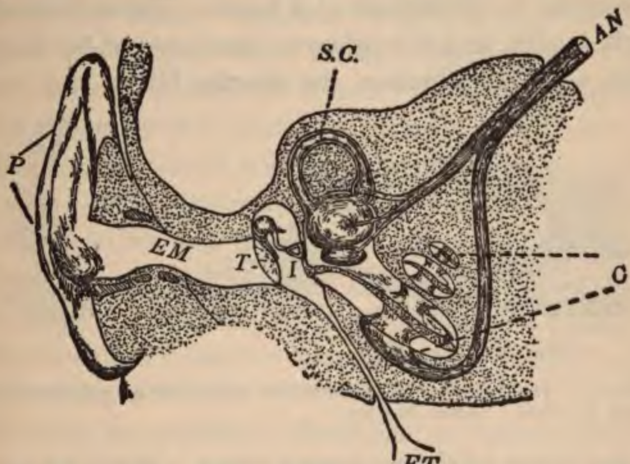

FIG. 16. Structure of the ear, showing *P*, the pinna or external flap of the ear; *EM*, external meatus or passage leading to *T*, the tympanum or membrane which separates the external from the middle ear (*I*); stretching across the middle ear is the chain of ossicles; *ET*, the Eustachian tube leading to the throat; *SC*, the semi-circular canals; *C*, the cochlea; *AN*, the auditory nerve. (From Judd, after Czermak, by permission of Ginn and Company.)

other bones and the tympanic membrane. One part of the labyrinth is a series of winding turns called, from the shape, the cochlea (snail-shell). Stretching across the passages in the cochlea is the basilar membrane (Fig. 17), which, with the structures resting upon it, is the true sense-organ of hearing, as the retina is the true sense-organ of sight.

The basilar membrane, if stretched out flat, would look somewhat like the sounding-board of a piano. Indeed, while it is a continuous membrane in character, it has running through it fibers that are somewhat analogous to the strings of a piano. These fibers differ in length, and it is believed that tones of the higher pitch set into vibration the shorter fibers, and tones

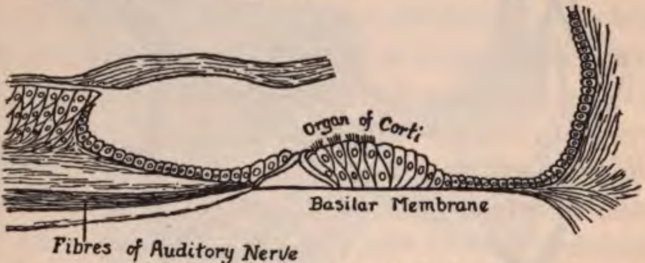

FIG. 17. Diagrammatic representation of the basilar membrane and organ of Corti. (After Sickley.)

of the lower pitch the longer fibers. The vibrations, thus taken up from the liquid of the middle ear by the basilar membrane, become converted into a nervous excitation which is carried to the brain by the auditory nerve.

Auditory fusions. — The eye and the ear differ decidedly in the way they are affected by combinations of their respective stimuli. It was noted, in connection with the discussion of color mixture, that the eye is unable to distinguish between two or more colors that strike it at the same time, but effects a compromise between them. Sensations of sound that occur simultaneously do not so completely fuse as do

colors, although the sound waves themselves reach the ear as a single complex wave. The ear has the capacity of analyzing out the elementary sounds of which a total complex sound is composed. It is probable that each fiber of the basilar membrane responds only to that part of the complex wave whose vibration rate is the same as its own, and that thus a separate nervous impulse arises for each part of a complex sound wave.

The human ear is sensitive to only a certain range of air vibrations, namely, from about 16 per second to about 50,000 per second. Above and below these limits no auditory sensation is received. Tone-deafness, a condition analogous to color-blindness, in which individuals are unable to hear tones of a certain register, sometimes occurs.

Hearing in children. — Reactions to auditory stimulation by turning the head begin to take place in the first few weeks of life; but these are probably instinctive actions implying no real recognition of the sounds. In some children appreciation of music is shown in the first year. About the middle of the second year there are the first attempts at singing, and probably the majority of children distinguish the tones of simple melodies in the fourth year of life. However, one investigator found that only about 20 per cent of children beginning school can sing a song by heart, and only about 36 per cent can imitate a simple melody. Great individual differences exist between children in their ability to sing, corresponding to the

great differences in this respect present in adults.

It is quite as important for the work of the schoolroom that the child should be able to hear distinctly as to see clearly. Tests that are approximately exact may be made by determining the distance at which the tick of a watch or a series of whispered words is heard. Tests were made in this way on school children of Liverpool, England. The children were first divided into three classes, bright, average, and dull, according to their ability in school work. It was found that the average number of inches a watch must be held from the ear so as to be audible was fifty-one inches for the bright pupils, 47.3 inches for the average, and 31.25 inches for the dull. Serious cases of defective hearing often exist without the teacher, and in some cases without the pupil himself, knowing anything about it.

Static sense. — The cochlea is the only part of the inner ear that is directly connected with the sense of hearing. The rest of the labyrinth, consisting of the semicircular canals and the vestibule (Fig. 17), are sense-organs of equilibrium. When the head is moved the liquid in the semicircular canals and the vestibule is set in motion, and this motion is communicated to small hair-cells, which in turn set up nervous impulses that are carried to the brain and result in muscular reactions that keep the body in an erect position. These impulses do not come to consciousness except when they are very intense, as in dizziness.

Smell and taste. — Smell and taste sensations are

usually experienced in combination with each other, and especially is it true that sensations of smell usually accompany what seem to be taste. Properly speaking, there are but four fundamental taste qualities, *viz.*, salt, sour, bitter, sweet. All other so-called tastes are compounds of these primary tastes together with smell sensations. Food owes most of its flavor to smell sensations, as can readily be seen by holding the nostrils or when the sense of smell is impaired because of a cold. Touch and temperature sensations also blend with taste sensations, and form a very essential part of what are usually called tastes. Some parts of the tongue are more sensitive to certain tastes than others. Thus the base of the tongue is more sensitive to bitter, the sides of the tongue to sour, and the tip to salt and sweet.

Smell and taste are relatively unimportant senses from the standpoint of education, but it is interesting to find that keenness of discrimination of these relatively lower senses is capable of a high degree of refinement. Ability to distinguish slight differences of odors and tastes may be pushed to a high degree of refinement by practice. Thus James vouches for the story that a woman who had lost her sight was able to sort linen in a laundry by the sense of smell, and it is a well-known fact that tea-tasters and connoisseurs of wines develop an astonishing capacity for observing slight differences in taste sensations. While in special cases a high degree of refinement in discriminat-

ing taste and smell sensations may be important, for the majority of persons such development is of little or no value.

Skin sensations. — There are four kinds of sensation that result from the stimulation of the surface of the skin. These are touch (pressure), pain, cold, and warmth. While we frequently get these sensations in combination, as we do those of taste and smell, yet they are in truth separate classes of sensations and have separate end organs. The latter point may be experimentally decided in the following way: Choose a certain limited area of the skin and mark it off by means of a rubber stamp into small areas of 1 millimeter square. Now, if each of these small areas be touched with a cold, bluntly pointed instrument, it will be found that at certain points the sensation of cold flashes up, while at others it does not. These so-called cold spots may be marked, and it will be found that they remain permanent from day to day. In a similar manner, by warming a blunt metal point, explorations may be made for warm spots, and it will be found that they are more numerous than the cold spots and not identical with them. So in like manner touch spots may be identified, and also pain spots.

Muscular sensations. — Besides the separate sense of pain, cold, and warmth, there must be added sensations connected with movements of the muscles. Some of these are brought about by the stimulation of sensory nerves in the muscles (muscular sensations),

others by the stimulation of nerves in the joints (joint sensations), and still others are connected with the tendons (tendon sensations).

The sense of touch (including muscular sensations) must share with those of sight and hearing the honor of playing the principal rôle in building up our knowledge of our own bodies and the external world. The degree of refinement possible in this sense is seen in the blind, who are very largely dependent upon it.

Sensations are first things in consciousness, and constitute the raw stuff from which knowledge of the external world and our own bodies is built up. A rich and varied stock of such experiences is necessary in order that one may comprehend the world aright and in its fullness. Furthermore, it must be remembered that these sensations are concerned in the guiding of activities. The further discussions of these points will be deferred till the end of the chapter on perception, since, as has already been shown, the processes of perception and sensation actually occur together and are not really separate processes.

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CHAPTER V

PERCEPTION

Relation between sensation and perception. — Perception has already been defined as *the consciousness of objects which are directly stimulating the sense-organs.* Sensations are continually thronging into consciousness; but they do not come, at least in adult consciousness, unrelated to each other. Certain sensations belong with certain others and go to make up our perception of a definite object. Thus the visual sensations (of color) coming from an inkstand at which we may be looking all combine and make up the percept of the inkstand. These particular sensations are grouped together, and other sensations received at the same time, such as those from the desk on which the inkstand lies, do not belong in the same group. So closely knit are sensations in a percept that the term "fusion" has sometimes been used to describe the complete union that exists between them. The sensations are bound together into a perceptual unity or oneness.

Sensations never stand alone. They never come to us as isolated factors of experience. The color red is always the color of some object; that is to say, it is always related to other sensations. Indeed, the sensa-

tions exist only as a part of perceptions, and it is not possible actually to separate the sensation from the percept of which it is a part. It is only through their combination with other sensations that sensations have any meaning whatever, so that from this point of view perception may be regarded as *the process in which sensations are given a meaning.* The materials of

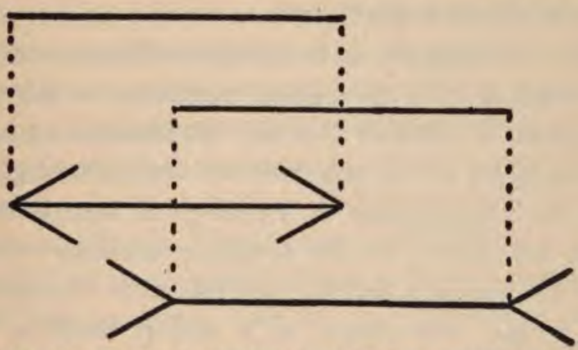

FIG. 18. The Müller-Lyer illusion. The two upper lines are equal and look equal. The two lower lines are equal but look unequal.

which the percept is composed consist of sensations, but its meaning is dependent on the way in which these sensations are arranged in consciousness. The interpretation is quite as much due to the way in which the sensations are related to one another as to their mere presence.

An illusion as an example. — Thus two horizontal lines that are of the same length such as those of the upper part of Fig. 18 are given the same meaning, except that they occupy different positions. But if there

are added to the horizontal lines oblique lines which are slightly different in the case of the two lines, as in the lower part of the figure, they have no longer the same meaning. The line at the right is interpreted as being longer than the line at the left. Notwithstanding the fact that the retinal images are of the same length, they are interpreted differently because of their different settings.

When it happens, as in the above illustration, that the meaning of a perceptual experience is false, the perception is called an illusion. All illusions are splendid examples of the principle we are discussing, *viz.*, that the interpretation of a perceptual experience depends not merely on the sensation-qualities but also upon the way in which they are related to one another. The person who shoots at a stump thinking it a partridge may have the same sensations as when he later discovers his mistake; but they get a different meaning because of their new setting.

The relating process present in all perception. — What is true of illusions is quite as true, though perhaps less strikingly, of all perception. The sensation gets its meaning from the connection it has with other sensations. The sensation of coldness may mean ice or ether or ice-cream, according as it is associated with this or that other sensation or group of sensations. A certain group of sensations of green, when associated with certain others of white and gold, mean

a book; but the same sensations may mean a lady's hat or the leaf of a tree in other connections.

Meaning also dependent on past experience. — The meaning that is given to a sensation in the perceptual process depends not only upon the other sensations that are immediately present, but also in part upon past experience. Our present experience of any object at which we look is dependent on our former experience with the same and similar objects. Most of our adult perceptions are immediately dependent only on visual sensations; but indirectly they are dependent very much on former sensations of other kinds, especially those of touch. The meaning of such an object as a watch, when we are looking at it, is bound up with the touch qualities that in former experiences have been connected with it. It is, of course, untrue that when we look at the watch we actually remember our various experiences of touching and seeing it and other watches in the past; yet they enter into the total meaning we give the experience.

Aristotle's illusion. — That the total meaning given to an object or situation is dependent upon past experience may be illustrated by a simple illusion of the sense of touch which was described by Aristotle and is known as Aristotle's illusion. If one crosses the first and second finger and touches an object, such as a lead-pencil, with the outside edges of the fingers, the object will appear double. This is because under ordinary conditions there must be two objects present

in order that they may give rise to touch sensations in these portions of the fingers at one and the same time. Hence, we give the present sensations of touch the same meaning as when we have had former similar experiences.

Filling in the blind spot. — It has already been pointed out that a certain small part (the blind spot) of the retina of each eye is not sensitive to light. If the left eye is closed, and the right eye is fixed steadily on the point marked with the cross in Fig. 19, and

FIG. 19. Diagram to show the presence of the blind spot and perceptual "filling in." If the left eye is closed and the right fixated on the cross, the black spot will disappear when the page is held about seven inches from the face.

the book moved *slowly* backward and forward, that is, away from and toward the face, there will be found a position about seven inches from the eye where the round spot disappears. This is because the round spot is now imaged upon that part of the retina which is blind. The interesting part of the experiment from the standpoint of our present discussion, however, is that, while the round spot disappears, there is no break in the background at this point. The background appears as a uniform surface. The interpretation or meaning given the experience depends on past experience, and, since such backgrounds are usually uniform, the usual interpretation is put on the present

experience, and the space is filled in, the background seeming uniform in character, even though no sensations are coming from a certain portion of the page, as shown by disappearance of the round spot.

All perceptual meanings derived from past experience. — While it is easier to see the influence of past experience in the case of such illusions as we have just described, it is quite as true that it forms an essential part of all our perceptual experiences. Our experiences of all the objects that we perceive are based on interpretations of present sensations made in the light of past experience. In this way the present visual sensations of yellow from a brass candlestick, for example, convey much more information than that of mere color. They are present signs of all past experiences of the smoothness to the sense of touch, the hardness, the coldness, and the heaviness, which have been experienced in connection with these and similar objects and which are now inextricably bound up with the present sensations of color.

The visual sense is usually the direct source of most of our perceptions, but the process is the same when other senses are the ones that directly contribute the sensations. When an object is touched in the dark, for example, past experiences of a visual sort assist in the meaning given the experience. The song of a bird, if it is familiar, gives a perception of the bird, which to some persons is more satisfying than seeing the bird. Such persons are naturally more sensitive

to sounds than colors and shapes of small moving objects, and their interests have been of such a character as to lead them to prefer the auditory meanings.

Since the perception of objects is not entirely the result of the present immediate sensations, it follows that our consciousness of objects is being continually built up and developed. A child's perception of objects is not to be regarded as the same as an adult's, nor one adult's the same as another's. What is seen, heard, and felt depends on what has been experienced, and we cannot take it for granted that a child sees just what we see, even though he is made to attend carefully. He lacks the necessary experience to put the same meaning into his sensations as does the adult.

Perception of space. — Thus far we have been engaged in discussing the perceptual *unity* of objects, that is, the relation of oneness which exists between certain sensations that go together to make up our perception of a single object. Besides the unity of perceived objects, there is another important relationship which exists between the sensory qualities of every object, namely, the relationship of space. Every object as perceived is located at a certain point in space and has size (length, breadth, and thickness). This relationship of space is an important aspect of the perceptual process. Careful analysis of space perception will show that the main points that we have brought out concerning perception in general are true also of the perception of space. Space as perceived is

(1) the result of gradual development, and (2) involves an interpretation based both (*a*) on the relating of present sensations to one another and (*b*) on past experience.

The characteristics of size and of position in space which objects have, seem at first thought to be immediately and directly experienced through the organs of sense as other qualities of objects. A little reflection, however, shows that, while such qualities as we have discussed in the chapter on sensations are all due to some form of physical energy (air waves, ether waves), no such physical forms of energy are related to the spatial characteristics of objects. Our further study will show that space is a type of relationship that has been built up between the various sensory qualities in the course of our experience.

Auditory space. — Not all the senses give us spatial experiences to the same degree. Smell and taste, for example, alone and without the help of the other senses, give us little or no information of the size and location of things. Hearing without the aid of the other senses gives us no notion of the size of things, though it does of their location. It is true that we can often tell by the nature of a sound something of the size of the object that has emitted it, since a loud sound usually goes with large objects and less intense sounds with smaller objects. But this information is clearly due to past experience in which other senses have cooperated with that of hearing.

By a simple sort of experimental analysis, it may be shown that when we are able to locate the direction from which sounds come, the ability to do so is not due merely to the auditory sensations simply as sensations. If a sound is made in the plane that runs vertically half way between the two ears, it will be found that without the aid of the other senses it is impossible to tell from what point in this plane the sound comes, although it is easy to tell that it comes from some point half way between the two ears. This is because a sound is usually located by the aid of the difference in intensity in the two ears. If the sound is at the right it is more intense in the right ear, and if on the left it is more intense in the left ear. It is this difference that is the cue to the location of sound.

This may be further proved by extending the experiment so as to make two sounds of similar quality at the same moment at both sides of the head, as may be done by the use of two telephones each of which is in the same electric circuit. If the two telephones are placed at equal distances from the two ears and sound together, there seems to be but one sound, located somewhere in the median plane (half way between the two ears). If the telephone on the right, however, is placed nearer than that on the left, so that the intensity of the sensation is greater in the right ear than in the left, the sound will appear to come from the right. This experiment illustrates very well what has been already referred to as perceptual fusion. Any

sound makes two impressions, one on the right and the other on the left ear. Nevertheless, in consciousness these two impressions appear as one; they are fused. In the total result a difference in intensity in the two impressions means for consciousness a certain direction. It is seen, then, that whereas locating sound seems to be a simple and immediate process, it is in reality complex and the indirect result of relating sensations to one another in the light of past experience.

Visual space. — Turning from hearing to vision, a similar problem confronts us, and the solution of the problem is also similar. Nothing seems more direct and immediate than the visual perception of the size of objects. But it may easily be shown that the sensations from seen objects are not sufficient ground for the perception of their size. If they were, the boy in Fig. 20 would look as tall as the man; for the drawings are of the same height and must make images on the retina that are of the same size. The picture, however, by its perspective suggests that the man is farther away than the boy. In addition to this, we have learned from past experience that boys in general are smaller than men. For these two reasons, although the picture of the boy is the same height as that of the man, the meaning we give to the picture is that the boy is smaller. Just so, in all our visual perception of size the retinal image is always interpreted in the light of such factors as distance and

past experience, as well as other factors that we cannot go into here.

FIG. 20. The actual height of the figure of the boy is the same as that of the man.

Perception of the third dimension. — The perception of the third dimension (thickness or depth) of

objects through the sense of sight is brought about in an analogous manner to the perception of direction of sounds. Sounds are heard with different degrees of intensity in the two ears. So also the retinal images from a solid object are slightly different. The right eye sees a little farther around the right side of a solid object and the left eye a little farther around the left side of the object. Just as the two impressions in the two ears fuse into one sound, the two impressions that come from the two eyes fuse into a single object, and just as the difference of intensity in the former case means direction, so in the latter case the difference in the retinal images means solidity.

These facts concerning visual perception of solidity may be proved very simply through the use of the stereoscope. This instrument makes use of two slightly different pictures of the same object or scene, these being obtained by photographing with two lenses placed a short distance apart. The stereoscope is so constructed that the right eye sees only the right-eye picture and the left eye only the left-eye picture. By means of lenses the stereoscope makes the two pictures appear to come from the same direction. Thus artificially we have reproduced by pictures conditions similar to those that are always present when we look at solid objects. The result is that in looking through the stereoscope at such pictures the objects represented appear solid and the distances between the various objects in the picture stand out as in real life.

Tactual space. — Even in connection with the sense of touch it is easy to show that the spatial meanings are not directly given with the sensations, but rather grow up gradually in the course of our experiences. If two points, such as the points of a pair of dividers slightly blunted, are placed at the same time on any portion of the skin, it will be found that they must be a certain distance apart before they are recognized as two points. If the distance is less they appear to the sense of touch as one point. If the points of the dividers are gradually separated, a distance will be found where they are just recognized as two. This distance at which the points are just recognized as two is called the spatial threshold for touch. Now, this threshold varies at different parts of the skin. It is small at those parts of the skin that are most used in actively touching things, such as the finger-tips, and very large on the unused portions, such as the middle of the back. Sensations of touch, then, on the finger-tips give rise to different space meanings from those that similar sensations of touch give in the middle of the back. Moreover, the spatial threshold of a given area of the skin can be reduced by practice.

Habits and perception develop together. — These are only a few of the facts that go to show that the world of space which we perceive is not immediately presented with sensations, but is gradually built up in the course of our experience. Objects are not reflected into consciousness as into a mirror, but the sen-

sations to which they give rise are merely the materials which are taken up and assimilated with past experience and with one another. Perception is, therefore, not a stable, unchanging process. The young child begins by making random movements, during which he comes into contact with objects that at first he neither perceives nor locates in the fully developed adult fashion. The groping movements of the child are not only due to his lack of muscular control, but also to the fact that he has not yet learned the spatial relations of the objects surrounding him. Objects far beyond his reach are grasped at. When he does come into contact by the sense of touch with objects, other sensations, such as visual and in some cases auditory sensations, from the same objects are present. All these are gradually fused and related so as to have meaning, including position and size.

In this process sensations from the muscles of the limbs and the eyes, which always arise when they are moved, are also of great importance in making up the total complex process of perception. At the same time, the sensory part of the process is accompanied by corresponding motor processes. The child cannot be said to perceive objects in any true sense until he has learned to react toward them. To react toward them means any sort of muscular reaction, either of limbs or eyes or ears, and all of these varied activities constitute perceptual habits.

A case of perceptual development in adult life. —

Most of our purely perceptual habits have been fully developed long before we reach an adult age. Moreover, the development that takes place is usually so gradual as to take place without being noticed. Some light on this point may, however, be gleaned from some illuminating experiments of Judd with the Müller-Lyer illusion. In the light of these experiments the Müller-Lyer illusion may be regarded as a case of undeveloped perception, for they show that a person may overcome the illusion through practice.

The experiment was performed in the following manner: A and B (Fig. 21) represent two pieces of cardboard, each containing a portion of the illusory figure. When B is placed over A in such a position that the horizontal lines are in one and the same straight line, the Müller-Lyer figure is obtained in one of its ordinary forms. A person who did not know of the illusory character of the figure was asked to set the cards so as to make the two horizontal lines seem equal. By measuring the two lines after this had been done, the experimenter could find out the amount of his subject's illusion. This process of setting the cards was repeated time after time without the subject being allowed to know the results of the measurements. It was found that after many trials made in this way the illusion disappeared, the cards being finally set so that the two lines were practically equal. The subject actually saw the figure in a different way, although he was not aware of the change. Perceptual develop-

ment had taken place in the course of the manipulation of the cards.

But this account of what takes place in the development of perception is not finished with the description of the change in the sensory processes. Along with the

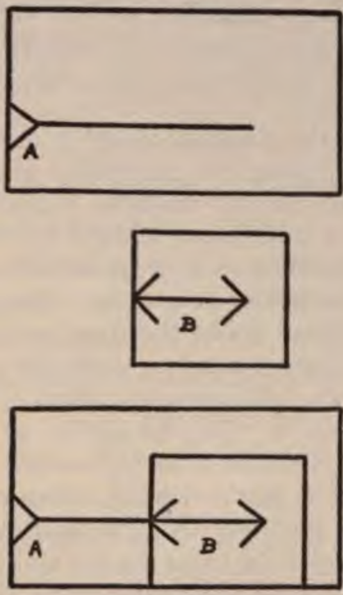

Fig. 21.

development in the perceptual process there develops a new *habit* of looking at the figure, as can be shown by photographing the eyes by means of a kinetoscopic camera. The movements of the eyes in following the lines of the figure were photographed before and after practice. The results show that the eyes move quite differently in passing along the lines after the illusion

disappears. Whereas at first the movements are impeded at the parts of the figure where the acute angles occur, after practice the eyes move smoothly along at these points. A new habit of eye movement has developed as a result of the practice.

Illustration from child life. — The way in which the sensory and motor processes of perception develop together has been well illustrated by Angell as follows:

Let us take the possible course of events involved in a baby's acquiring the perception of a bell. Obviously the visual factors involved cannot be satisfactorily employed until some control has been attained over the eye muscles, so that the child's eyes are able to converge and follow an object. This attainment is commonly achieved about the third or fourth week of life, although there is great variation here. If the child never touched the bell and never heard it, he might still learn to recognize it, when he saw it, as something he had seen before; but he evidently would have no such perception of it as you or I have. As a matter of fact, the bell will be put into his hand, and during the random movements of the hand his eye will sometimes fall upon it. The occasional repetition of this experience will soon serve to fix the association of the touch-hand-movement feelings with the visual consciousness of the bell, so that the thing seen will inevitably suggest the thing felt and moved, and *vice versa*. Moreover, all the time this has been going on there have been sensory stimulations of sound from the bell. This group of elements, therefore, becomes annexed to the rest of the group, and straightway we have the rudiments of the process by which, when we see or touch

or hear a certain kind of object, we promptly perceive it as a bell, *i. e.*, as a something to which a certain mass of familiar experience belongs.

In this description may be seen the two ways in which the child begins to acquire a mastery over the world of objects around him. The development is both sensory and motor. Not only does the group of sensations from the object become organized into a unified whole with a definite meaning, but an organized response or habit is developed. Furthermore, the sensory and motor sides of the process are parts of a total process that is itself unified and organized. In other words, perception and the motor response develop together, and the meaning of the experience is bound up not only with sensory impressions but also with the adjustments to which they give rise.

Apperception. — We have seen that there are two phases to the process of perception: (1) the reception of sensory impressions and (2) giving to these impressions a meaning or interpretation. While the second part of the process is essential to perception, some writers use a separate word—apperception—to distinguish this aspect of perception from the mere reception of sensory impressions. Apperception is, then, the process of assimilating present experiences to the whole background of former experiences. Since new experiences are always interpreted or given a meaning in the light of old experiences, the new can be cor-

rectly interpreted only if the person has the correct background of former experiences. For this reason it is of little use to present new experiences to the child unless his mind is prepared for the reception of the new facts. One cannot properly take for granted that the child has the correct background of experience for the proper interpretation of any new material whatever. Careful investigations of what the child knows when he enters school shows that the children of one neighborhood differ very much from those of another in their knowledge, and that one individual child differs much from another in this respect. Many city children, for example, know nothing of natural objects that much of the instruction of the school takes for granted. Girls and boys differ very much in relation to the kind of things they know.

These facts are the more important since it is a well-known tendency of the child, with his limited experience, to fall back on pure fancy for the meanings that he gives to new experiences. This is especially true of the meanings of words for which the child has not had the corresponding concrete experiences. It is a tendency of the human mind—and, as we shall see later, a very useful tendency—to supplement the gaps in our knowledge by imagination. But in the child this tendency is a weakness, since it leads him to accept all sorts of fanciful meanings that give rise to error. The child lacks the wide experience and the critical judgment necessary for curbing the flights of imagina-

tion. The same tendency and weakness give rise to children's lies, many of which are not so serious from the moral point of view as is sometimes thought. They point to intellectual weakness and lack of development rather than to moral obliquity.

All of this goes to show that the child needs a first-hand knowledge of concrete objects and situations. Intellectual development begins with and is based on perception. Each sense brings us a knowledge of the external world that can be obtained in no other way, and so all the so-called higher intellectual processes, such as memory, imagination, conception, judgment, and reasoning, are dependent on the data given by these senses. The only substitute for actual contact with objects and events is through some form of symbol (pictures, maps, models) or word symbols. At best the symbol is a poor substitute for the actual thing; but a word is an absolutely empty symbol without first being connected with the proper experience, since it in no way is like the object and can represent it only by convention.

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CHAPTER VI

MEMORY AND IMAGINATION

The mental image.—A mental image is the *experience of objects that are not at the time stimulating the sense-organs.* One may close the eyes and yet call to mind the visual appearance of an object. One may have in one's consciousness a melody that is not actually the result of present hearing. So, too, there are mental images belonging to each of the other sensory spheres, olfactory (smell), gustatory (taste), tactual (touch), etc.

While mental images do not depend upon present stimulation of the sense-organs, they nevertheless depend upon former sensory stimulations. It is impossible to have a mental image except in so far as the elements of the image have been experienced through the senses. A person born blind does not have any visual mental images. Such a person cannot even imagine what a visual mental image is like. None of us could imagine in any adequate way what an experience would be like which depended on some sense-organ that we do not possess. Mental images are reproductions or revivals of past sensory experiences.

Imagination.—Mental images, however, may be

formed from new combinations of old elements, and in this sense they are new. When this recombination or reconstruction of the old elements has taken place in mental imagery, the process is called *imagination.* The results of imagination vary all the way from pure fancies, such as sea-serpents or centaurs, to historical romance and scientific invention.

It is probable that mental images, even in the form of memory images, are never absolutely faithful reflections of the past. A mental image is never more than a representation of what has been already experienced. But it has also the advantage of being made over to suit the individual's own convenience. This reconstructive process always goes on to some extent. Ask two persons who have witnessed the same events to recount them, and they will differ, often very vitally. Not only have they observed the events differently, but they have remembered them differently. They put a different emphasis on what has been observed, and the result is the discrepancies in their accounts.

Memory.—When the mental images are *recognized* as coming from the past, they are known as memories. Memories range from events that are definitely located in time and place to facts that have been learned and are merely referred to the past, though not definitely.

Behavior based on images indirect.—It will be seen that mental imagery arises, not immediately from our

experience of objects, but indirectly. For this reason, behavior based on mental images is related not so much to the immediate environment as to what has happened in the past and what may happen in the future. Man, because of the capacity for forming these images, becomes independent of his immediate environment. His conduct may have reference to future ends, and may be governed according to past experience to a greater extent than is the case with animals incapable of forming mental imagery.

It is at this point that man begins to be most sharply differentiated mentally from the lower animals. For, even though it may possibly be true that some of the higher of the lower animals have this capacity, nevertheless their behavior is for the most part called forth by the immediate stimulus of external objects. On the other hand, all of man's most significant behavior is made on the basis of future ends and in the light of past experience. For example, man provides food and shelter because he foresees their necessity. Some of the lower animals, like squirrels and bees, lay up a supply of food, but their actions in this respect are instinctive and probably imply no picturing to themselves of the future occasions when the food supply will be needed.

It is in this way that man becomes to a large extent independent of his environment. He learns his environment as it actually is through perception, and reconstructs it mentally. His actions are then gov-

erned by these mental reconstructions. Man is thus free to act according to inner motives and conditions of his own making, while the lower animals are bound by their immediate circumstances and the compulsion of external events.

Some learning does not involve true memory. — While this statement is true, it must not be thought that the lower animals cannot profit by past experience. Animals far down in the scale of animal creation are capable of learning. It might be said that this implies memory on the part of such animals. It is true that it implies at least retention; but, properly speaking, memory involves more than mere retention. It involves recognition, a conscious reference of the experience to the experiencer's past. As we have already seen, past experience always enters into the interpretation of the sensory data in the process of perception. But there is no consciousness in such cases of the part that past experience is playing. The past experiences connected with the objects perceived have become so organized into the present experience as not to be a recognizable factor except by such an analysis as we made in discussing perception.

Conditions of revival. — Theoretically every perceptual experience we have ever had is capable of being revived at some time in some form of mental image; but practically only a limited number of these experiences are actually revived. Since the practical usefulness of the ability to form mental images depends

upon the possibility of reviving the earlier experiences when most needed, it is of the utmost importance that we should know what the conditions for revival are.

Mental images form a related series. — First of all, we note that our mental images do not usually occur in purely haphazard fashion, but are suggested either by something we hear or see or otherwise experience perceptually, or else by some other mental images. Here as elsewhere in our mental life, the processes are not separate and independent, but are related to one another; they form a related series or train of processes.

It may perhaps be questioned whether all of our mental images are suggested by other experiences. Things frequently seem to "pop into the head," as we say. In many of these instances a little careful introspection will show that there were really present some experiences that have escaped our notice, and these are the experiences that have suggested the apparently sudden thought. In other instances, however, as in the persistent revival of a melody that keeps running in the head for a long time, the mental images seem to be revived merely because of their own strength and not because they have been suggested by anything else.

Law of association — The general rule, however, is for mental images to occur by virtue of other experiences with which they have been associated. This principle is usually referred to as the law of associa-

tion, which states that when two experiences have occurred at the same time or successively the revival or recurrence of one of them tends to revive the other. The revival of the second experience is the more likely to occur the closer the association that has been formed between the two experiences. The closeness of the association will depend on various factors which will now be described.

Recency. — Other things being equal, the more recently the experiences occurred together the more likely are they to recur together. While we do not exactly know what brain processes are at the basis of association, it seems that connections of some sort must exist between the nervous elements whose functioning is related to the associated mental images. We have already learned to look for the connections between neurones at the synapses, and we have seen that there is evidence that the resistance of the synapses between various neurones varies with use. It would appear that the synapses between the neurones that we are now considering are the more open to the passage of the nervous current the more recently they have been used.

Much of what is known as learning consists in the formation of associations. It is, of course, trite to state that the more recently a thing has been learned the more likely is it to be remembered; but to rely on this factor of recency in education, as in the case of cramming for examinations, is a bad practice, since it

is productive of no permanent results. On the other hand, there are some circumstances, such as when facts or figures must be at one's disposal for a single occasion, when to rely on this factor is a useful method of remembering and perfectly legitimate.

Frequency. — A factor in the process of forming associations that is of far more significance for learning is that of frequency. Other things being equal, the more frequently experiences have occurred together, the more likely are they to be revived together. The principle of the overcoming of resistance in the synapses by frequency of use has already been described in connection with the subject of habit formation. The same principle holds here. Indeed, it may be said that the process of association is only a special case of habit formation. Permanent associations cannot usually be established without frequent repetition; hence the necessity of drill in education.

Vividness. — There is one way, however, in which a permanent association may be set up without frequent repetition. That way is by means of making the experiences come together in a vivid fashion. Anything is vivid to consciousness that is sufficiently attended to. Hence, the better the attention to an associated series of experiences, the less frequently will it be necessary to repeat it in order to make it a permanent possession of the mind. Since vividness depends on attention, the conditions for making effective use of this factor in forming associations will be the same condi-

tions as relate to attention in general, and these will be discussed later.

Primacy. — A special condition of vividness is primacy. Experiences met with for the first time are particularly vivid, as expressed by the well-known phrase, "First impressions are lasting." For this reason it is extremely important that a learner should get what he is learning correctly the first time he meets with it. Otherwise, he not only has to break down an incorrect association, but he also loses the advantage that comes from the strength of the first impression.

Emotional tone. — The fourth factor governing the strength of associations is the feeling and emotional character of the experience. Experiences that arouse intense emotions are usually, though not always, on that account more easily remembered. In general, feelings of a pleasurable sort facilitate learning, and unpleasant feelings retard it. Since it seems to be a general law of our natures to forget what is unpleasurable more easily than what is pleasurable, it is important that the learner's activity be of a pleasurable nature if the conditions make it possible. The pleasurable feeling that usually accompanies learning is interest, which will receive separate treatment in the chapter on attention.

Mental set. — There is still another factor determining association, which may modify the effect of the factors already mentioned. Recency, frequency, vividness, and emotional tone describe conditions under

which associative links were originally made. But the condition of consciousness at the time when the suggested image appears may be quite as important in determining its appearance as these past conditions. At any moment consciousness has a certain trend or direction representing the interest of the individual at the time. This mental set, or attitude, will be a factor in determining which of many possible associated images will appear. The word orange, if heard in the class-room when studying sensations, is likely to suggest the color; if heard at the breakfast-table, the fruit itself is more likely to be called to mind.

It will be seen that this phase of the associative process is closely related to that aspect of perception which is sometimes called apperception. Indeed, this term is sometimes used to describe the influence of "mental set" in determining associative experiences. Each individual has his own particular mental sets, sometimes relatively permanent, sometimes temporary, which predetermine his associations in a certain way, varying with his occupation, moods, and interests.

Amusing illustrations of the effect of "mental set" are sometimes obtained from those well-known "catch" questions where an attempt is made to predetermine a person's mind in a certain direction, with the object of making him make mistakes. Thus, if a person is asked to spell "to" the preposition, "too" the adverb, and "two" the number, and then to spell the name of

the second day of the week, there is a great probability that he will think of Tuesday rather than Monday.

It was this aspect of the mind's functioning which led the Herbartians to require the step of "preparation" as the prerequisite to every inductive lesson. The purpose of the preparatory step is to give the pupil the proper "mental set" toward the new material of the lesson. By question and answer the teacher revives those of the pupil's former experiences that are likely to be of value in interpreting the new material, or supplies such information as is necessary for a proper understanding of the lesson.

Free associations. — Most of the experimental investigations of association have dealt with word associations. One method is that of so-called free association. Here the subject is asked to begin with some word (let us say "play") and write as many words as come to mind in a certain time, one after the other. Under such conditions a surprising number of words are repeated by all who take the test. One investigator found that the hundred words that occurred most frequently in fifty such lists made up three-tenths of the total number of words.

Another form of the free association method is that in which a list of certain words is given as the *stimulus* words and the time is taken for the response to each by means of a stop-watch. Many facts of importance in the mental life have been discovered by this method. It is found, for example, that some of the words re-

quire a much longer time for the response than others. Such words are usually discovered to be connected with experiences in the subject's life that have a strong emotional tone or that the subject for some reason wishes to conceal. A criminal, for example, would be embarrassed in responding to words suggestive of the crime, and this method has therefore been used to detect knowledge of crime.

Such results are directly related to the views of Freud, who holds that many mental disorders result from the undue repression of natural desires, especially those of sex, or from experiences of a strongly emotional character which the person seeks to forget. These experiences frequently date from early childhood and are, in fact, forgotten, but their effects still persist. The educational significance of Freud's views is in their warning against requiring the child to submit to unhealthy repressions. In the discussion of instincts we have seen that educational ideals require that natural desires should be modified. The repression of instinctive desires is not dangerous if wisely undertaken. In matters concerning sex relations, especially, an atmosphere of greater frankness should exist between the child and the adult. Only in this way can our moral standard be preserved without running grave danger of injuring the mental life of the young.

Controlled association. — The second form of the association experiment is that of *limited* or *controlled* association. Here the subject, instead of being allowed

to respond to the stimulus word with any word he chooses, is required to respond as quickly as possible with one of a very few words that can fit the terms of the instructions. Common forms of this test are the part-whole, opposites, and genus-species tests. If the test is the part-whole test, the word "tree" would be a correct response to "branch"; if the opposites, "shut" would be followed by "open"; if genus-species, "tree" would bring the response "maple" or "oak," etc. Tests in arithmetical computations (addition, subtraction, etc.) are illustrations of the strictly limited form of association, since the response in each case is limited to the only one that is correct. Table I gives the results of the genus-species tests in terms of the scores made by children from eight to sixteen years of age. The words used were door, pillow, letter, leaf, button, nose, cover, page, engine, glass.

TABLE I

Age............	8	9	10	11	12	13	14	15	16	Adults
Median........	6.5	7.8	7.8	8.7	8.7	9.0	9.0	9.0	9.0	10

Individual differences in mental imagery. — It has already been pointed out that mental images may belong to any one of the sense spheres. It has been discovered that different individuals think about the same things by means of different kinds of mental images. Thus some individuals seem to prefer visual images, others auditory, and others tactual, etc. Usually the preference for a certain class of imagery is not so great

as to preclude all other kinds of mental images, but a marked preference may exist. One who thinks predominantly in terms of visual images is called a visualist; the audile is one who prefers auditory imagery; the tactile prefers tactual imagery; and the motile is one whose images are chiefly revivals of muscular sensations. In many cases two or even more of these forms of imagery may occur simultaneously.

If, for example, a person forming a mental image of an orange sees "in his mind's eye" a colored object, round in form, he is using the visual form of imagery. Another person in thinking of an orange might think of its touch qualities, such as the roughness of the skin, as it would appear if passing the finger-tips over its surface. This would be a tactual image. Undoubtedly there would be other persons whose images of an orange would be revivals of its taste qualities—that is, gustatory images.

An object is frequently thought of without forming any image of the qualities of the object itself, but rather of the word standing for the object. In thinking of an orange a mental image of the sound of the word "orange" (auditory image), the visual image of the word as printed or written, or the revival of the sensations from the speech muscles (kinaesthetic image) as they would be used in pronouncing the word may all be used as substitutes for the direct image of the object.

Word imagery. — A great deal of mental imagery is thus not directly concerned with objects at all, but with

words. Word images are much more convenient for purposes of thought than thing imagery. One reason for this is that thought frequently has to do with that which cannot be experienced in the form of objects. For most persons it is more convenient to think of electricity through the medium of the word than to imagine it as an object. Many persons doubtless do have imagery of a definite kind in thinking of electricity—but most do not. The word image for the latter group becomes a convenient substitute for thing imagery. It carries the meaning. So, too, of all sorts of relationships that we have to represent to ourselves in thinking. They are much more easily thought in the form of word images.

The individual differences in mental imagery are found in connection with word imagery as well as thing imagery. Perhaps the majority of people think in terms of auditory-motor word imagery. Others, however, have visual pictures of the printed or written words. Some public speakers, for example, see in their mind's eye the words as written on their manuscripts.

Number forms. — Individual differences in imagery are well illustrated by a way of imaging numbers and the alphabet, the days of the month, and so forth, which is peculiar to some people. The most common of such ways of imaging are those known as number forms. Those persons who have number forms think of the numbers as arranged in a certain spatial order. Fig. 22 represents one of these forms. The individual

who has this form thinks of 1 as being spatially located in the direction from 2 indicated in the figure. Each of the other numbers has also its definite place in the scheme.

Some of these individuals think of the numbers or letters of the alphabet as having characteristic colors. Such imagery is probably too concrete to be as useful as the ordinary types of imagery, where the vagueness of the image helps it to fit many similar situations and thus make it more easily a general notion, that is, one that will stand for many situations of the same kind. On the other hand, those who have such imagery frequently assert that it is most useful for certain purposes, such as keeping engagements and remembering dates, etc. Number forms and personifications are probably more common in younger people and

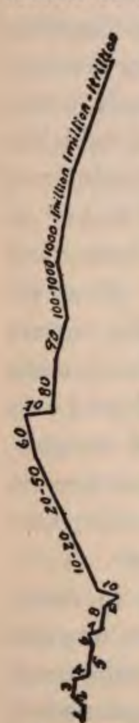

FIG. 22. Illustrations of visual forms of days in the week and of numbers.

are largely outgrown as the person gets to be more abstract in his thinking.

Imagination. — The term imagination in its widest sense is the image-making faculty. In this sense memory images are particular classes of the process of imagination, viz., those where the images reproduce with fidelity a former experience. In so far as images appear in consciousness that are not faithful reproductions of past experiences, they may be described as belonging to imagination in the narrower sense of the word. Imagination in the narrow sense comes close to the popular use of the word as that which is purely fanciful. The fanciful or unreal character of some mental images arises through the ability to *combine* in consciousness elements that have been experienced only *separately* in perception. Thus the words "the cow jumped over the moon" in the nursery rhyme bring up imagery that is purely fanciful, because they combine experiences that can be combined only in the form of mental imagery. Even such imagery, which is contradictory to all sensory experience, is, however, frequently of value because of the enjoyment to be obtained from these novel combinations.

Function of imagination. — The ability to reconstruct and recombine in thought is, however, of much greater importance than that of mere enjoyment. Imagination finds its chief function in those cases where it is possible actually to modify our environment so as to make it accord with our mental images, as in inventions. Other cases of a similar sort are those where one looks ahead to certain possible situations, by forming

images of that which is likely to happen and makes preparation for the future in this way. Take, for example, the complicated preparations necessary for a polar expedition, which are possible solely because of the ability to imagine what is likely to happen. In such forms of the imagination man goes much beyond the stage of mere fanciful imagination useful only for purposes of enjoyment. He has the capacity thereby "to look before and after"—"to prepare for war in time of peace." As far as we can tell, the lower animals are able to do this to a very limited extent, most of their provisions for the future being purely instinctive.

Furthermore, many of the most important scientific facts can never be directly experienced through the senses. They must, in other words, be imagined. Ether, electricity, gravity, atoms, etc., are all facts that could be experienced in no other way. Imagination helps to fill in the gaps of our sense experience, and thus gives a truer picture of reality than the senses can without its aid. The truth of the picture in such cases is dependent largely on whether these products of the imagination actually correspond with, and do not contradict, those sense experiences on which they are built.

Development of imagination.—This last statement gives the proper clue to the cultivation of the imagination. It is known to everybody who has studied children that they revel in imaginary experiences. Two extreme views have been held with regard

to the wisdom of cultivating this tendency, both of these views being the result of psychological misconception. According to one view, since imagination is false and impractical in its results, the child's tendencies in this direction should be restrained. Fairy stories and myths should be replaced by "what is true." The other view holds that, since imagination is natural to the child and since it is a useful function, it should be cultivated as much as possible, and one should be careful not to break into the fancies of childhood by the introduction of prosaic reality.

The truth that follows from a correct analysis of the situation has been foreshadowed in our earlier treatment of this subject. Imagination is a useful function in so far as it leads to useful activities. Not every fancy, therefore, contributes to a useful end, but only those that may be made to conform to reality either by leading to actual constructions or by furnishing products of imagination that are useful because of their literary, artistic or scientific character. It is when the child is not taught to distinguish sharply between the truth and falsity of his imaginations that harm arises from a cultivation of the imagination.

Furthermore, it should always be remembered that imagination is dependent for its content on sensory experience. The cultivation of imagination, therefore, requires rich and varied experience of the world of external objects and events. Such means of developing those forms of imagination that we call scientific

and practical are clearly necessary. But the following testimony from a great writer of fiction, Sir Walter Scott, shows its necessity in cases that we ordinarily regard as far removed from sensory experience. While visiting a certain Mr. Morritt, Scott said to his host:

"You have given me materials for romance: now I want a good robber's cave, and an old church of the right sort." "We rode out," says Mr. Morritt, "and he found what he wanted in the ancient slate quarries of Brignal and the ruined abbey of Eggleston. I observed him noting down even the peculiar little wild flowers and herbs that accidentally grew around and on the side of a bold crag near his intended cave of Guy Denzil; and could not help saying that, as he was not to be on oath in his work, daisies, violets and primroses would be as poetical as any of the humbler plants he was examining. I laughed, in short, at his scrupulousness; but I understood him when he replied that in Nature herself no two scenes were exactly alike, and that whoever copied truly what was before his eyes would possess the same variety in his descriptions, and exhibit apparently an imagination as boundless as the range of nature in the scenes he recorded; whereas whoever trusted to [purely fanciful] imagination would soon find his own mind circumscribed and contracted to a few favorite images, and the repetition of these would sooner or later produce that very monotony and barrenness which had always haunted descriptive

poetry in the hands of any but the patient worshipers of truth."[1]

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[1] Quoted by Bolton, Principles of Education.

CHAPTER VII

CONCEPTION

Conception. — The relating of experiences to one another is of the very essence of the mental life and manifests itself from the beginning. If the hypothetical first moment of consciousness is, as James believes, "a blooming, buzzing confusion"—merely a vague mass of sensations bare of meanings—from that moment forward such masses of experience begin to be broken up (analyzed) and the parts related to one another (synthesized). Insofar as these processes have to do with sensory experiences exclusively, the relating activity brings about the development of perception of objects in the manner described in Chapter V.

But along with the relating of sensory qualities into the forms of unity and space there is going on another relating process, which finds its chief manifestation in the higher processes of thought and is their indispensable foundation. While the perception of an object, in so far as the perception itself is concerned, is always the experience of a particular object, the object is usually at the same time identified and placed mentally as belonging to a class of objects. The table at which

we are looking, for example, is not merely this perceived object. It is included mentally in a whole group of objects, some of them quite unlike in many respects the one now being looked at. *The process of marking off a thing in thought, of identifying it or classifying it, is conception.*

Abstract ideas. — Concepts that refer to classes of objects are sometimes called *general ideas.* Those that refer to qualities and relationships are called *abstract* ideas, since they are abstracted or separated in thought from the objects to which they belong. The quality of whiteness, for example, may be thought of as a separate quality that is classed with the similar quality of other objects. A concept may refer to objects, qualities, activities, and relationships that have never been and by the very nature of things never can be experienced perceptually, such as God, gravity, atoms, electricity.

Words are conceptual signs. — It is evident that the process of conception is closely bound up with language. To name a thing is to identify and classify it. Furthermore, it is much easier to identify and classify a thing if it is possible to name it, so that language is not merely a means of communicating ideas from one individual to another, but it is an aid to thinking. The reason for this appears as soon as we make an analysis of the concept.

Analysis of the concept. — If we attempt to discover just what mental content is in our minds when we use

the word "table," it will be found that individuals differ greatly from one another and that the same individual may have an entirely different content at different times. Usually, however, some kind of mental image is present. This image may be either visual or some other preferred form of image. Perhaps it is an image of a particular table that may even be recognized, as in the case of the memory image. In other cases the image will be vague and fleeting and may not call to mind any particular object of the class. The essential thing, however, in all these cases is that the image carries with it a general meaning; it represents any object of the class.

By far the most common form of image present under such conditions is some kind of word imagery. The meaning is conveyed by the reproduction in the mind of the visual appearance of the word "table" as printed or written; or the sound of the word as pronounced may be present as a mental image; or the image of the muscular contractions used in pronouncing the word may be the preferred form; or, finally, any of these forms may be combined with others or with the thing imagery mentioned in the last paragraph.

Word imagery has an evident advantage over thing imagery for the purpose of conveying general meanings; for an image of an object is always an image of a particular object, and therefore has characteristics that are quite different from many of the other objects of the class represented. In the case of the word, on

the other hand, the general meaning attaches itself to the image more readily since the word is, of course, in no sense like the object represented by it. The word image is also a great aid in forming concepts of objects and relations that are not experienced perceptually.

Meaning dependent on motor reactions. — How can any image that in itself is *particular* mean—that is, stand for or symbolize—a *class* of objects? The answer to this question carries us back to the perceptual experiences that are the foundation for concepts as well as the other higher processes involving mental imagery. In our study of perception we found that objects when perceived bring about characteristic motor responses. Objects of a similar kind are reacted to in similar ways. Chairs, whatever their shape and size, are sat on or to be sat on. Books are objects to be used in certain ways, tables in other ways, and pencils in still others. Our world of objects is so constituted that, in order to be successful in our dealings with them, it is necessary to act in a common way toward those that belong in the same class.

Obviously, the motor activities that are present in perceiving objects are not always such externally observable actions as those concerned in actually manipulating them. Ordinarily the motor responses end in muscular contractions that cannot be detected; but, as we have already seen, sensory impulses always issue into motor tracts, and the entire muscular system is, therefore, in a continuous state of changing equilib-

rium. Consider the thousands of distinctly different motor reactions that give rise to vocal speech, which are also present in incipient form (inner speech) when the word is merely thought of.

Now, not only does the percept carry with it a characteristic motor attitude, but the revival of the perception in the form of a mental image is also accompanied by a motor attitude of a similar sort. Hence the meaning of the mental image may be a general meaning, notwithstanding the particularity of the image as such, because the meaning is the attitude that was attached originally to the perceived class of objects. Thus the image is merely a symbol and has a general meaning because it is associated with an attitude connected with a form of motor reaction common to all the members of the class of objects represented.

Word meanings. — What is true of other forms of mental imagery is also true of word imagery, which gradually tends to become the typical bearer of meanings for most people. Language is a conceptual system in which the separate words are used to bear the meanings originally attached to objects, relations, and events. The word, being a pure symbol and in no sense a copy of the object represented, is peculiarly adapted to carry with it the general meaning. If the word "dog" can be used as a substitute in thought for the animal itself, it is because the word carries with it something of the same kind of motor response as

would be evoked by actual sensory experience of the dog.

Because of the infinite number of possible words, symbols can be made not only for perceivable objects represented by the nouns of a language, but of relationships and activities that are symbolized by the verbs, conjunctions, and prepositions. Each of these has its general meaning, so that it may become the means of communication as well as an aid to thinking.

Development of concepts. — What has already been said implies that our ideas or concepts are gradually built up in the course of experience, and are continually changing. The meaning of the concept changes as experience broadens. Sometimes the meaning narrows so as to include fewer and fewer objects. For example, the child familiar only with cats will at first include dogs under the same category, but his further experience teaches him to differentiate them. Sometimes the meaning becomes more and more inclusive. Contrast, for example, the astronomer's concept of "star" with the child's idea of the same object.

Dangers of too hasty generalization. — Since conception has its roots in perception, it becomes obvious that there are dangers attendant upon too hasty generalization. No adequate concepts can be formed, for example, of scientific facts from merely learning words descriptive of science. The meanings of words can be made adequate only if the words have aroused the appropriate motor reactions. Now, it is true, as

we have seen, that concepts of a most valuable sort may be formed of what has never been experienced through the senses and can by the nature of things never be thus experienced. Indeed, it frequently happens that our conceptions of things are quite opposed to our perceptions. This is because in perception we are limited to certain kinds of relationships, like those of unity, space, and time. Perceptually, the sun moves in the heavens and the earth stands still, yet we know that the reverse is true. We believe that the sun stands still and the earth revolves, because, in the first place, we have much other evidence that the mind may be deceived by merely trusting sense impressions, and, in the second place, the hypothesis of earth revolving and sun standing still explains a number of other sensory experiences, like those of day and night. Were it not for this evidence we should regard the now accepted view of the relationship between the sun and the earth as the sheerest nonsense, the product of as idle a fancy as that of the cow jumping over the moon in the nursery rhyme. While, therefore, the conceptual process continually goes beyond the data furnished by perception, it is untrustworthy unless it can be made to square with the facts of sensory experience. Furthermore, there is grave danger that the meaning will be vague and uncertain if the concept is formed without being based on sensory experiences. Words are mere empty symbols if the necessary sensory

experiences and their correlative motor reactions have not been used in building up their meanings.

Concept of the self. — Among the concepts that play an important part in the life of all individuals is the concept of the self. Our descriptions of consciousness up to this point have been piecemeal. We have examined the various patterns exhibited by consciousness from moment to moment. In so doing we have disregarded to a large extent, for the time being, the unity that exists between one moment of consciousness and all other such moments. Throughout the changing phases of consciousness from moment to moment, from day to day, and from year to year, we remain the same self. Each passing phase belongs to the total stream that we call ourself and that self, notwithstanding the changes, remains in some sense the *same* self.

Bodily self. — This concept of the self, like other concepts, changes with experience, and is the result of gradual processes of development. The young child probably has no concept of self as the adult knows it. At first his consciousness is all of the type frequently characteristic of adults when the self is completely forgotten, as, for example, in watching a burning building, totally absorbed in the events going on around one. When the child first begins to think of himself as a self, it is of an objective or bodily self. Of all the objects that are perceived by the child, the body is the one most intimately connected with his experience. Unlike other objects, it is always with him. He cannot

escape from it. Many of his sensations, such as pain, come to him without any object of which he is aware being there to produce them, and these are referred to the body. When he touches his body the experience is quite different from that of touching other objects. He therefore begins to distinguish between the body and all other objects, and to think of his body as that peculiarly intimate thing, himself.

Spiritual self. — As time goes on, even the body is looked upon from certain points of view as an object. Religious teaching and the ideas of older people in general lead the child to differentiate between his true self (soul or spirit) and the bodily self. Many kinds of experiences, especially those connected with death and reflection upon the ultimate destiny of human beings, have been influential in making this concept of a spiritual self a generally accepted one.

Memory and the self. — The most influential factor in establishing the view of the self as a unitary and persistent entity, notwithstanding the constant changes of consciousness, is that of memory. I am the same self as I was yesterday, and the day before, and the year before, because I can at the present moment call to mind earlier experiences and recognize them. Under certain conditions the nervous system may become so disarranged that memory of past events is wiped out. If this loss of memory is not merely temporary the person becomes virtually a different self,

and we have the phenomenon of double or multiple personality.

Certain experiences of the individual become split off from the main personality and are organized so as to form virtually a new self. Frequently the two personalities alternate, with practically no memory links between the two phases of the conscious life. Sometimes the secondary personality lasts for years, with no memory of the former self and with a practically complete change in the character and behavior of the individual.

Hypnosis. — Less striking, because more temporary and more under control, are the phenomena of hypnotism where dissociation enters, causing a temporary forgetfulness of the normal waking self which is practically complete. The experiences undergone during the state of hypnosis are also forgotten when the hypnotized person is in his normal condition. The hypnotized person is extremely suggestible; that is, an idea that comes to his mind is immediately acted on. If the suggestion is made during hypnosis that the hypnotized person act in a certain way after the effects of hypnosis have passed, the person is likely to perform the action even though the circumstances in which the suggestion was given are forgotten. This has been made the basis of curative treatment for mental disorders and bad habits. For example, the drunkard is hypnotized and given the suggestion that in the future drinking will sicken him, or simply that

he must not drink. The effect lasts over and in some cases may actually be the cause of reform.

Subconsciousness. — One interesting point in such cases is that we have demonstrated here that the behavior of an individual may be due to forgotten or unnoticed experiences. Not all of man's behavior is, therefore, related to the surface phenomena of consciousness, which are easily open to introspection, but many causes for action lie below the surface. As James has said in a passage quoted earlier, "Nothing we ever do is in strict scientific literalness ever wiped out." These hidden experiences which contribute their effects in all our behavior are sometimes referred to as *subconscious* processes.

Voluntary action. — The suggestibility of the hypnotized person throws light on the relation between ideas and action. Any idea that comes into the mind under such conditions is acted upon. The results may be absurd and contrary to the person's usual mode of behavior, but the hypnotic effect is such that each idea that comes to the mind has a clear track and issues in some corresponding action. Under normal conditions the idea works itself out in action in the same way to the degree to which it is the exclusive object of attention. But usually more than one idea is present in consciousness at the same moment, each striving, so to speak, to bring about its appropriate action. Action is thus delayed by the presence of competing ideas,

and what we call deliberation, reflection and choice ensues.

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CHAPTER VIII

THINKING

Various uses of the term. — The words "thinking" and "thought" refer in every-day speech to those conscious processes that are not of direct sensory origin. Sometimes they are primarily memory processes, as when a person says, "I am thinking of my old home." Sometimes thoughts are more of the nature of imagination, as when it is said, "I am thinking of the good time I expect to have on my vacation." Sometimes, however, thinking refers to the process of arriving at conclusions or beliefs, as when we think out a problem or think what ought to be done when difficulties present themselves. All of these cases of thinking are similar in that they consist of a chain or series of *ideas* rather than direct perceptions, and in each case the series of ideas centers about a common purpose or theme. But those instances of thinking of the type where problems are solved are of sufficient importance to demand special treatment. They are instances of rational or reflective thinking.

One function of the school is to train the child to think. — While man has been called the rational animal, thinking of the reflective type is relatively un-

common in the ordinary affairs of life. Our instinctive and habitual ways of acting are usually sufficient for dealing with the situations that present themselves from moment to moment. Occasionally, however, our usual modes of response are inadequate, and difficulties arise. Under such circumstances thinking takes place, and direct action is delayed until the thinking is completed. One of the chief functions of the school is to create situations that demand thinking of the reflective type. In every-day life such situations are not only infrequent, but when they do occur they are usually of a more or less trivial character. In the schools, on the other hand, the pupil is continually confronting problems to be solved, and, artificial and formal as they often are, they are the chief means we have of training the thinking capacity in the young.

An illustration of thinking in practical affairs. — Some illustrations may serve to make clearer the nature of reflective thought. Let us take, first, an example typical of those that occur in the ordinary affairs of life. I have made an engagement which requires that I shall be in the town of X, thirty miles away from my home, at 4:30 P. M. of a certain day. It is necessary to determine how to get there. On looking up the railroad connections, I find that there are only two trains that go to X from my home, and neither of these trains is convenient because one is too early for my engagement and the other too late;

furthermore, there is no train that will bring me back that evening. I remember that X has railroad connections also with Y by a different line, and that Y can be readily reached by trolley; but on looking up the time-table I find that the trains are quite as inconveniently arranged as by the first route. Another possibility is that of going by trolley all the way. This I dislike to do because of the time consumed, the lack of ventilation of cars likely to be crowded, etc. I might take a taxicab, but the expense is against this plan. It occurs to me that my friend *A*, who has an automobile, has relatives in X whom he occasionally visits. Perhaps he is contemplating such a visit and may be induced to make his visit coincide with my plans. *A* readily consents to this plan, and I am thus enabled to meet my engagement and return the same evening in a comfortable manner and without expense.

Dewey's illustration of reflection involving experiment. — Another illustration, given by Dewey, is more typical of those with which the teacher tries to confront the pupil in his school work. In this case the problem would not be likely to occur spontaneously in the mind of a person not intellectually alert or trained in scientific methods of thinking.

In washing tumblers in hot soapsuds and placing them mouth downward on a plate, bubbles appeared on the outside of the mouth of the tumblers and then went inside. Why? The presence of bubbles sug-

gests air, which I note must come from inside the tumbler. I see that the soapy water on the plate prevents escape of the air save as it may be caught in bubbles. But why should air leave the tumbler? There was no substance entering to force it out. It must have expanded. It expands by increase of heat or by decrease of pressure, or by both. Could the air have become heated after the tumbler was taken from the hot suds? Clearly not the air that was already entangled in the water. If heated air was the cause, cold air must have entered in transferring the tumblers from the suds to the plate. I test to see if this supposition is true by taking several more tumblers out. Some I shake so as to make sure of entrapping cold air in them. Some I take out holding mouth downward in order to prevent cold air from entering. Bubbles appear on the outside of every one of the former and on none of the latter. I must be right in my inference. Air from the outside must have been expanded by the heat of the tumbler, which explains the appearance of the bubbles on the outside.

But why do they then go inside? Cold contracts. The tumbler cooled and also the air inside it. Tension was removed, and hence the bubbles appeared inside. To be sure of this, I test by placing a cup of ice on the tumbler while the bubbles are still forming outside. They soon reverse.

The five steps in the thinking process. — An analysis of the above illustrations and all similar cases of reflective thinking shows that there are five steps, more or less distinct, though often merging into one another, in the course of the solution of such problems.

These are (1) a perplexing situation, which causes a feeling of difficulty; (2) noting clearly the source and nature of the difficulty; (3) forming various ideas which may possibly solve the difficulty; (4) considering what the results would be if these various ideas were accepted; (5) further observation and (sometimes) experiment leading to the acceptance of one of the ideas and the rejection of the others.

Training the child to look for problems. — In the first of our two illustrations the felt difficulty is forced upon the thinker because of the practical necessities of his daily life. In the second there is no such practical motive for further inquiry: the occupation of dish-washing could proceed successfully without further ado. But to the active, trained mind every experience not understood is a challenge to thought. This attitude of active inquiry, having its roots in instinctive curiosity, may be either fostered or stifled by the atmosphere of the school. Among the more purely intellectual attitudes to be cultivated, there is probably none so important as that which leads to reflective thinking. Indeed, the attitude that leads to doubt, inquiry, and independent thinking has something in it of moral quality as well as intellectual. He who comes to his beliefs, opinions, and knowledge simply on the authority of others can scarcely be said to be honest.

Importance of suspended judgment in thinking. — The second step in the thinking process is not always

clearly defined. Frequently the first and second steps merge into each other, as in the first example given above, where the nature and source of the difficulty are evident from the outset. In many cases, however, it forms an important part of the necessary procedure. The difficulty with the solution of the problem frequently arises from not observing the facts that are present carefully enough. Thus, if an automobile engine stops running, all the occupants of the car are aware that there is a difficulty; but only those who are used to observing the way in which automobile engines usually run will have any clear indication of the source of the difficulty. The driver is likely to have observed certain indications of the difficulty, such as unusual sounds or vibrations, before the engine stopped, and such indications frequently show just where to look for the seat of the trouble instead of a blind process of guessing. As Dewey puts it: "The essence of critical thinking is suspended judgment; and the essence of this suspense is inquiry to determine the nature of the problem before proceeding to attempts at its solution."

Importance of imagination in thinking. — The mind gets to close grip with its problem when suggestions of the possible solution of the difficulty begin to form. Clearly, the capacity most involved at this point is imagination. The mind makes a leap, so to speak, from what is actually perceived to ideas that will serve to explain the observed circumstances. The kind of

imagination needed here is, of course, not imagination in the popular sense of pure fancy, but in the form of ideas that are guided and controlled by the facts but that nevertheless go beyond them. It has already been pointed out that imagination of this profitable sort cannot be developed by fairy stories and the make-believes so zealously recommended by some parents and teachers. Abundance of sensory experience of the right sort, and continued application of such experience in the formation of concepts that are embodied in laws, rules, and principles, is necessary. Doubtless, fertility of suggestion is much dependent on a person's innate ability, and is the mark of originality; but even the person of common-place mind may think out the greater part of his problems successfully if he has the necessary background of experience and training. Continued application of such experience in the formation of concepts that go beyond the present in time and space and casual relationships are necessary.

The fourth and fifth steps in reflective thinking. — The next step is that of determining what would be the necessary implications of the various ideas suggested. If such or such suggested solution of the problem is accepted, what consequences follow? The fifth step consists in determining whether the conditions found to be required by the fourth are actually present. If so the hypothesis is regarded as correct. If not it is rejected. Frequently it happens that new facts are noted which had hitherto been overlooked, tending to

confirm the probability or improbability of the suggested hypothesis. Frequently, too, the suggestion itself is modified so as to make it conform to all of the facts observed to be present. The process of verification thus set up often leads to experiment where the conditions thought to be vital to the phenomenon are rigidly arranged and the consequences carefully noted. Here we get the highest type of scientific verification.

Induction and deduction. — The third and fourth steps mentioned above are the very heart of the thinking process, and taken together constitute the process of reasoning. The third step is of the nature of inductive reasoning. Induction is the process of passing from particular facts to a general idea that comprehends all of the facts. The results of the inductive process give us concepts, rules, principles, hypotheses, and laws. The value of such general principles is that they furnish a single comprehensive way of thinking about things and events that would otherwise be entirely isolated from one another. They give to us a way of thinking that can be used in any situation to which they are applicable, and when we have such comprehensive views of particular facts we say we understand them—can explain them; for by means of them they are all connected with one another in their proper relationships.

The fourth step constitutes the process of so-called deductive reasoning. When we apply a general prin-

ciple, law, or idea to a particular case falling under it, we are said to proceed deductively.

Thinking consists of associated trains of ideas. — Obviously the mental processes involved in thinking are concepts or ideas. One idea is followed by another, the whole constituting a series of associated ideas—all proceeding toward a certain goal, namely, the solving of the problem. Thinking may go wrong either because false ideas have been taken for granted or because these ideas have been put together in wrong ways. Logic examines the proper procedure for correct thinking, and constructs rules to guide the process. The ideas that are taken for granted are called the premises, and the outcome of the thinking the conclusion. Logic gives us rules for both the inductive and the deductive phases of thinking.

Inductive vs. deductive methods of teaching. — Inductive and deductive methods of thinking have often been set over against each other as different methods of approach in teaching various subjects of study. Whenever we begin instruction by setting up general principles, rules, and definitions, and proceed to make these principles, rules, and definitions apply to particular instances, we are proceeding deductively. Whenever we take the reverse course of proceeding from particular instances to build up rules and definitions, we proceed inductively. Complete thinking, as we have seen, includes both the inductive and the de-

ductive processes; but considerable differences in methods of instruction frequently appear, according as we emphasize the one or the other method of approach.

One might take as an example the general principle that metals are good conductors of electricity. A lesson in electricity that began with a statement of this principle and then proceeded to illustrate the rule with reference to various kinds of metals would be based on a deductive method of treatment. The inductive method of approach, on the other hand, would begin by the demonstration of the facts of conduction in the case of as many metals as could be conveniently tried out. It would begin with the concrete facts and build up the general principle from a consideration of the individual cases. This method has the advantage of carrying the student from what he already knows to what is unknown. The general principle, therefore, when arrived at has a fullness of meaning for him which would not be present where the statement of the principle is given without the background of concrete experience from which it has been derived. The order of discovery of general principles is by the inductive method, and this method of teaching implies that each student should make the discovery for himself. On the other hand, if we begin deductively, the acceptance of the general principle on the part of the student must be made on the basis of the authority of the author of the text-book or the teacher.

Doubtless there are times when it is advisable to teach rules and principles from the outset, either because of the inability of the student to make the necessary induction, or because of the impossibility of securing the concrete evidence, or because this method will lead to more immediate results in the application of the principle; but in general the inductive method of approach is the more suited to the student's comprehension and leads to more valuable habits of thinking.

Study in relation to thinking. — Much of what we call study in the schools properly implies that the pupil is or should be engaged in the process of reflective thinking. Usually, however, the facts, the problems, and the solutions are all presented to the pupil by the teacher or text-book. The student is simply required to think over again for himself the results of the thinking of others. If this is actually done by the pupil great gain results, but pupils often fail to realize that study is anything more than the mere memorizing of facts, problems, and solutions. Since the problem has not arisen out of his own experience, he neither recognizes the problems nor takes the steps for their solution, except in a mechanical way. In the recitation and the assignment of lessons, therefore, one of the teacher's chief functions is to stimulate the pupils to take the problem-solving attitude toward the material of the lesson.

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CHAPTER IX

LANGUAGE

Language derives its usefulness from indirect results. — The great importance of language for human society and its intimate relationship to thinking make it desirable that its nature be considered in some detail. When considered apart from the meanings that words convey, language is simply a form of behavior. Oral speech consists of a series of contractions of the vocal muscles, just as movements of the arms or legs result from contraction of the appropriate muscles. Written language, from the same point of view, is merely the result of muscular contractions of the hand and arm.

But the true significance of language does not arise from the direct results of these actions. If the arm is stretched out to pick up a book, the muscular action is directly useful. In the case of language, however, the importance of the muscular action comes from its indirect results. Action of the muscles in speech does nothing by way of affecting objects. Why, then, does this particular form of action become so important?

Animal language. — It will aid us in answering this question if we attempt to discover something of the

origin of language and its manner of development. It is well known that some of the lower animals have means of communication with one another that may be regarded as forming a sort of language. Dogs give information to one another in a limited degree by means of their barking; deer give warning to their fellows by a toss of the head, and many other species of animals have their characteristic signs—in most instances, however, limited to signals of danger.

Such language can scarcely be regarded as of the same nature as human language, although it does bring about similar results. It is probable that in most cases of animal behavior in response to signals of this sort the action is purely instinctive. Chicks hatched in an incubator, for example, will respond in the usual way shortly after birth to an imitation of the hen's danger call. Certainly it is true that the information conveyed from one member of a species to another is very limited. When the danger call comes, the animal simply acts in the way that is characteristic of that species when danger is present, without having any definite information of the nature and source of the danger.

Human language began with natural signs. — The study of language shows that it has been the result of a gradual process of development from simple beginnings. Various theories have arisen to account for its origin, but all agree that, originally, spoken words in some way *directly* indicated what was intended to be

communicated by means of the sounds. For example, while the word "cat," to one who has not associated it with the animal, would have no significance, imitating the mew of the cat would immediately suggest the animal to any one who had any acquaintance with cats. While the word "joy" would have no special significance to any one not knowing the English language, the cry of joy would be recognized by everybody. It seems probable also that originally many objects and situations instinctively evoked characteristic sounds among primitive peoples. The mere utterance of these sounds would, therefore, serve to suggest the objects or situations to the hearer. All such instances of primitive means of communication are illustrations of the use of *natural signs* to convey meanings, and are closely related to animal language in being an outgrowth of emotional reactions in the presence of exciting situations.

Gesture language. — In the early stages of language development gestures undoubtedly supplemented sounds to a greater extent than in the more developed languages of to-day. The gesture is, at first, also a natural sign of the object or act signified. Pointing to an object to which attention is to be drawn, or drawing in the air an outline of its shape, or imitating an action helps to communicate to an observer the meaning that it is desired to convey.

Conventional signs. — Further development of language takes place through the gradual passing over

of these natural signs into *conventional signs,* and the multiplication of conventional signs in a more or less arbitrary or accidental manner. As soon as this stage is reached, there is virtually no limit to the number of oral or gesture signs that may be used, for the meaning is now conveyed, not by any likeness of the sign to the thing signified, but as a result of common usage and agreement among the members of a community. The conventional meaning is, of course, not a result of any conscious agreement, but grows up gradually in the manner of other customs.

Sign language of deaf-mutes. — The sign language of deaf-mutes furnishes an excellent example of the way in which natural signs pass over into conventional signs. Deaf-mutes who are untrained in alphabetic sign language fall back on the use of natural signs. These signs are so directly indicative of their meaning that deaf-mutes of different nationalities can understand one another on meeting for the first time. Furthermore, these gestures are very similar to those in use by primitive peoples, who, although they have a spoken language, use a great many gestures. Wundt is authority for the statement that "gestures that refer to specific concrete objects are frequently so similar that many of the signs employed by the gesture language of the deaf-mutes of Europe may be found among the Dakota Indians."

The following description shows two methods employed by deaf-mutes to express the fact that two ob-

jects are different. The important point about these descriptions is that the first method is more of the character of a natural sign, while the second illustrates signs at a more conventional level. The more primitive method is: "The deaf-mute endeavors to place the two interesting objects side by side, and leads his interlocutor up to them; touching the objects one after the other, he makes a sign of emphatic denial" (shake the head) "if *A* differs from *B*.

"A more conventional form of gesture for expressing differences is as follows: Place both forefingers side by side, the other fingers being closed and the backs of the hands turned upwards, then move the hands away from each other, the forefingers pointing in opposite directions. The degree of difference is expressed by the rapidity and extent of the movement. A rapid and full sweep of the two fingers until the arms are extended at full length, if accompanied by an earnest gaze, means 'wide as the poles asunder.' A slow, hesitating movement, with a look of uncertainty, indicates a small difference, only just noticeable, of no special interest."

The simplification of natural signs. — As soon as the principle of using symbols, oral or gesture, which were not like the things symbolized became firmly established, there was virtually no limit to the degree to which oral and other signs might be used. Natural signs were changed, in the interests of simplification and ready use, into conventional signs. Because of

the wide range of possible speech forms and the fact that the vocal muscles are not, like the hands, used for other purposes, oral language took precedence over gesture language. When languages become thus freed from the necessity of making their symbols like the things symbolized, they become not only a medium of expression but a means of thought as well.

Obviously it is difficult to find natural signs for anything except the simplest objects and occurrences. Natural signs are suitable for expressing only a limited range of the more concrete happenings of the external world. Abstract ideas are either very difficult or impossible of expression in this way. The deaf-mute takes a long time and much effort to express so simple an abstract idea as that conveyed by the one word "different." If it were necessary for him to express the kind of difference, it would become still more difficult. The more abstract the meaning to be conveyed, the more difficult it is without recourse to conventional language.

Language not a definite instinct. — The child, in learning to speak, roughly parallels the development of racial language just outlined. It is a debatable point whether the child has any instinct of speech. Certainly if there is such an instinct it must be very indefinite, for a child of any race will learn the language of any other if it is the only one he hears, and he will do this as readily as if it were the language of his parents.

Early steps in speech development. — The first sounds made by the child are of the nature of emotional expressions, such as the cry of pain. Soon, however, he begins to exercise his vocal apparatus in "cooing" and "gurgling." In this babbling period there arise a variety of sounds that are made spontaneously and with no thought of communication. Nevertheless, by modification of these the first words are learned, and they therefore form the instinctive roots of speech. Thus, among the babbling sounds produced are such reduplications as *mă mă* and *dă dă,* which the child learns to modify into "mama" and "daddy" under the influence of repetition of these sounds by adults. Gradually such sounds are given the conventional meanings because they are associated so frequently with the appropriate situation, object, or person.

Imitative stage. —Starting with these fundamental spontaneous sounds as a basis, the child soon enters on an imitative stage of development of speech. At first the child imitates the words of others very imperfectly and largely for the pleasure derived from the exercise of his vocal functions rather than for language purposes. He soon, however, begins to attach meanings to spoken words uttered by himself and others. This is the inevitable outcome of the fact that his most vivid and interesting experiences are almost always accompanied by spoken words. Those words are understood most readily whose meanings are akin to the emotional expressions. At this stage the child's at-

tempts at oral language are supplemented by gestures, especially by pointing.

The great majority of the early words acquired are nouns, and when first used these words are generally made to do duty for entire sentences. For example, "Milk" ("Give me some milk"), "Down" ("I want to get down"). The arrangement of words in sentences is without much regard to conventional order and without proper reflection, as, for example, "Know what that?" "Salt on my" ("I want salt on my nuts"), "Grape want," "This what I play." At this stage the comprehension of the meanings of words used by others is far in advance of the number of words used by the child.[1]

Children's definitions. — It is interesting to note that children in their early years almost always define words in terms of use. Thus an orange is "to eat," a chair "to sit on," a river means "where you get drinks out of and catch fish and throw stones in." Such facts give interesting confirmation to the view discussed in the last chapter that meaning is the counterpart of motor attitude.

Oral speech usually quite fixed by school age. — By the time the child is of school age he usually is able to pronounce in the conventional way the words constituting his vocabulary. Many children, however, even at this age need careful training in overcoming defects of speech, such as stammering, lisping, etc. The range

[1] See Kirkpatrick, Individual in the Making.

of vocabulary varies greatly with individual children, depending on intelligence and the environmental conditions. Naturally, the child of a cultured home is in a position to make more rapid progress in language development. Making due allowance for these differences in environment, it seems probable that language capacity is a fair indication of intelligence.

Some investigators of the language development of children hold that there is a period of peculiar interest in language between the ages of eight and fifteen. At this period many children invent secret languages. This would seem to be a favorable time for learning foreign languages. At any rate, it is certain that as far as speaking a foreign language is concerned the earlier it is begun the better, for adults rarely learn to speak any language but their own without an "accent."

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CHAPTER X

ATTITUDES—ATTENTION, FEELING, AND EMOTION

Consciousness presents a characteristic pattern. — When consciousness is observed at any one moment, there is found to be present more than one percept, idea, feeling, or other conscious process. But these processes are arranged according to a certain pattern. There is always one process, or group of processes, that is most prominent and stands out with greater clearness than all others. Among these others there are also varying degrees of clearness. This aspect of the mental life is called attention. Attention is not a power within consciousness that makes it assume this characteristic pattern where some processes are central and others marginal. It is rather the name used for convenience in summing up in one word this particular aspect of consciousness.

Various figures of speech are frequently used to describe the facts of attention. It may be said, for example, that those conscious processes that are most prominent are central and the others peripheral; or that the former are focal and the latter marginal. Those that are so far removed from the focus of attention as

to be completely unnoticed, but that show their presence by their subsequent influence, are sometimes said to be subliminal, that is, below the threshold of consciousness. Fig. 23 may be taken as a rough representation of the facts. The central area stands for the point of greatest attention, while the outlying areas represent, by their varying distances from the center and their different shading, the various degrees of clear-

FIG. 23.

ness of those factors that are outside the point of greatest attention.

Let us suppose a person is writing at a certain moment. The uppermost thing in his mind is the idea or thought to be expressed. This point occupies the focal point of attention. But at the same moment he may be conscious of the paper on which he is writing and the characters formed, though these are not noticed to the same degree as the thoughts he wishes to express. There will probably be many other processes vaguely present in consciousness at the same time—for example, sensations from contact of his fingers

with the pen he is using, sounds from the street outside, and many sensations from his own body, such as the discomfort due to the bent posture.

Shifting of central and marginal factors. — One of the most interesting features of the attention process is the continual shifting that takes place between the central and the marginal factors. No one factor remains long in the point of greatest clearness, and the marginal elements frequently become central and a moment later give place to others. In this way a selection is being made from moment to moment of those experiences that are most significant for a person's needs. In the illustration just cited, for example, one thought follows another for some time, and the writing largely takes care of itself. But if doubt arises as to the spelling of a word, or if the pen becomes dry, or if the pain in the back becomes too intense, any of these may demand attention to the exclusion of thought.

The selective aspect of attention. — We are surrounded by all sorts of physical sources of energy, which are continually changing. Nature has equipped us through our sense-organs with the capacity to note some of these changes (though not all) and to govern our behavior accordingly. There will be, however, among these changes that are brought to consciousness some of more importance than others. These are selected in the sense that we become more clearly aware of them and react to them to the exclusion of the

others. Add to all these physical forms of stimulation the memories, thoughts, and feelings that are so prominent in the conscious life of man, and the need of the selective process of attention is still more apparent.

Attending to more than one thing at a time. — It is probable that we never really attend to more than one thing at a time, though that one thing may be complex. The attention may, however, pass from one thing to another and back again so rapidly as really to amount to the same thing. The ability to do this is characteristic of some persons of more than ordinary ability, among whom was Julius Cæsar, who is said to have been able to dictate four letters while writing a fifth. There is also the possibility of performing more than one activity simultaneously, provided some of them are so well learned that they do not require attention to them. In certain abnormal states some individuals perform activities, such as that of automatic writing, without even knowing that they are taking place. The extreme marginal elements in consciousness seem to be concerned in these activities.

Classification of attention. — We have now to inquire why we attend to some things and not to others. We may be aided in this inquiry by drawing a distinction between spontaneous or passive attention and voluntary or active attention. Attention is said to be involuntary, passive, or spontaneous when it is given naturally and without effort or where we are interested in what is being attended to. Attention of this sort

is almost always, though not invariably, accompanied by pleasurable feelings. Spontaneous attention may again be classified into (1) native or primary, (2) acquired or secondary.

Inherited spontaneous attention. — Just as we found that our organisms have an original nature to behave in certain ways (instincts), so it is also true that it is a part of our original nature to attend to certain things. The first answer to our question of why we attend to certain things and not to others is, then, that it is natural to do so. It is a part of our inherited constitutions. We see this kind of attention clearly manifested in the child from the very beginning of his life. For example, from the time the baby begins to notice things about him, he follows with his eyes moving objects. His attention is caught by bright colors and loud noises. These are situations that tend to attract the attention all through life. Another type of attention-drawing situation is change of any sort. The clock-tick may remain unnoticed as long as it continues, but it is very likely to draw one's attention if it stops suddenly. Add to these situations all that call forth instinctive responses, like those of imitation, play, curiosity, etc., and it will be seen that we are so organized from birth as to attend to a large number of different kinds of experiences, just as we are organized from the beginning to behave in certain ways that are the reflex and instinctive responses to various stimuli.

The acquired form of spontaneous attention may best

be described after we have discussed voluntary or active attention.

Voluntary attention. — In the third chapter it was shown that, besides the native capacity to behave in certain ways (instincts), we have the capacity for learning new modes of response (habits). So, too, with attention. We are fitted by nature to attend to certain things, but we have also the general capacity to attend to that which is not natively interesting. This kind of attention requires effort, and it has therefore been called voluntary or active. The child soon learns to recognize the importance of attending to what is not immediately interesting because of its future value. This is increasingly true as he begins to live in a world of thoughts and ideas, as contrasted with perceptions. The importance of most of these objects of attention has been already discovered by parents and other older persons with whom the child comes in contact, and social pressure is brought upon the child to attend to these things. All forms of work and study are good examples of activities requiring voluntary attention.

Acquired spontaneous attention. — But the similarity between behavior and attention in their development does not end here. The more frequently new forms of behavior take place, the easier they become; and the more frequently we voluntarily attend to a new form of activity, the easier it becomes. The effort becomes less and less; in other words, the attention becomes less voluntary until finally we reach a stage

when an interest has been developed in the new thing or activity for its own sake. An acquired interest has been developed. We thus reach a stage of attention which is like the native spontaneous attention in its effects, but which has had an entirely different origin, the one form being inherited, the other acquired.

Perhaps no better illustration of the development of secondary passive attention can be given than to cite the interest that certain studies gradually acquire when persistently pursued. The development of interests of this sort is one of the teacher's chief duties. It must not be supposed that in any particular instance of attention it is easy to separate the factors that are native from those that are acquired. It is possible and even probable, for example, that the basis of interest in certain lines of study is inherited. It is undoubtedly true that individuals differ greatly in their inherited interests, and that there are important sex differences in this respect.

Interest. — The word "interest" as commonly used has two somewhat different meanings. It may mean the pleasurable feeling that is present when we are attending spontaneously and without effort. Interest is also used, however, to designate those more or less permanent dispositions, both native and acquired, which cause a person to attend in a certain direction. It is in the latter sense that a person may be said to be interested in music or painting or geometry. From what has been said it should be clear that the teacher

cannot create outright an interest that does not exist. If the child is interested in any thing or activity, it is either because he has been endowed by birth with an inclination to be interested in that direction or because he has developed it through former experiences.

Conditions for attention must be present. — It would be no proper answer to our inquiry as to why we attend to this rather than that at any moment to reply that it is merely a matter of determining to do so. Active attention, like passive, is subject to conditions. Ideas, especially those that have a future reference and those that express the purpose of the moment, past experience, and heredity all enter in as factors to determine the direction of attention. So, too, in the case of the secondary or acquired form of passive attention, its explanation is to be found in the individual's past history. In neither case is it possible to understand the act of attention by considering only the present instance of its activity. For the child to give attention at any particular moment it is necessary either that his mind should have been prepared through past experience, or that he should be naturally interested in the object of attention, or both.

Attention related to motor processes. — Attention, like other phases of the conscious life, is closely related to muscular processes. There is a certain bodily "set" corresponding to each phase of the attention process. Thus in the visual sphere attention to an

object involves the turning of the head and of the eyes so that they are fixated on the object (convergence); and also the muscular process of bringing the image of the object to a focus on the retina (accommodation). In listening attentively the drum membrane of the ear assumes a degree of tension suited to the character of the sound. Touch sensations are made clearer by active movements of the fingers, etc. Similar activities take place with smell and taste sensations.

Furthermore, intellectual attention is also accompanied by characteristic muscular processes. Changes in circulation and respiration are among the most important of these. In momentary concentration of the attention, especially in listening, breathing becomes slower. Different persons have different bodily habits during intellectual attention, such as wrinkling the forehead, knitting the brows, doubling the fist, or clenching the teeth. The more intense the concentration of the attention becomes, the more extensive and intense are these bodily changes.

These bodily processes serve to reinforce and adapt the body for the particular form of attention to be given. They are, therefore, of prime importance in education. To adopt the correct attitude of attention is a primary requisite for arousing the attention itself. The inattentive [1] child may be aroused to attention if

[1] Properly speaking, inattention is attention to something other than that which the teacher desires the child to attend. Under such conditions the passive form of attention is uppermost.

required to assume the proper bodily attitude. On the other hand, it is easy to overestimate the practical importance of movement. Children are much more given to energetic bodily expression of attention than are adults. They wrinkle their brows in working, move their lips, make movements with their heads and fingers to a much greater degree than adults. This seems to be a useless expenditure of energy which is later overcome.

Attention and observation. — Attention to material objects and events, when methodically and carefully carried out, is sometimes referred to as observation. Some light is thrown on the development of attention and the other processes concerned in observation by experiments in description and report. These experiments are carried out by having the child observe one or more objects or a picture for a short time (say half a minute) and then describe what has been observed. Sometimes questions are also asked to supplement the report. From the results of such experiments Stern has described four stages or levels in the development of observation: (1) Substance stage. The young child merely enumerates the various persons and things he has noted one after another. There is no attempt to state any connection between these persons or things. (2) Action stage. The chief objects of attention at this stage, which begins at about the eighth year, consist of the activities of people. (3) Relation stage. Spatial, temporal, and causal relations

are reported at this stage, which comes from the twelfth to the fourteenth year. (4) Quality stage. Finally the properties of the things observed are analyzed and noted.

Stern found that, in general, persons are much more apt to be observed than things, objects are more apt to be noted than their qualities and relationships, and that spatial relationships are more apt to be described than colors. Children are more apt to jump at conclusions with regard to what they observe than are adults, and are more apt to be certain that they are right even when as a matter of fact they are wrong. They are more suggestible than are adults.

Training in observation. — Training children in observation should not have as its purpose the impossible one of teaching the child to observe the details of everything it is possible to observe. Attention is a selective capacity, and derives its usefulness in part from the fact that it concentrates on some things to the exclusion of others. The ordinary affairs of life lead to the observation of those things and events that are most useful for our immediate purposes, but such observation is too limited to meet the higher demands of scientific knowledge and esthetic appreciation. Accordingly, the child needs training in observation, not for the sake of training his capacity for observation in general, but for broadening his interests in those really significant things that would otherwise be overlooked. In order to do this the child must be taught not merely

to observe but what to observe and what to look for.

Feelings and emotions classified as "attitudes." — Attention has been called a selective attitude of mind. It is that phase of conscious activity which emphasizes some one part of the conscious activity of the moment as the one to which we shall react, and at the same time inhibits others from seeking their normal outlet in action. Among the other most important phases of consciousness that are also to be classified as attitudes are the feelings and the emotions.

Simple feelings accompany most of the other conscious processes. — Simple feelings are among the most common aspects of the mental life. They are those experiences of pleasantness and unpleasantness which accompany nearly all, if not all, of our other conscious processes. Sensations, for example, almost always have a feeling tone of some degree of pleasantness or unpleasantness. Normally a sweet taste is pleasant, a sour taste unpleasant; some colors and especially some combinations of colors are pleasing, others displeasing. So, too, sounds, tastes, odors, and various kinds of touch sensations, warmth, and cold have their characteristic qualities of agreeableness or disagreeableness. Again, our thoughts, imaginations, memories, and other so-called higher processes are attended by experiences of pleasure and displeasure.

Attitudes are subjective. — These feeling attitudes are clearly to be set over against the cognitive aspects of consciousness as constituting a different class of men-

tal processes. The difference is sometimes expressed by saying that attitudes are more subjective than the cognitive processes. In some sense the experience of color, of sound, of touch is an experience of the qualities of an object. But the agreeable or disagreeable feeling is in no sense inherent in the object; it represents the reaction that the individual makes to the object—a reaction of acceptance or rejection.

The subjective nature of feelings is further emphasized by the way they differ in character under various circumstances, though accompanied by the same sensory content. Thus the more intense pain caused by pressing an aching tooth is frequently agreeable. The odor of tobacco, usually fragrant to the smoker, is strongly obnoxious if he is seasick. In some moods nothing pleases, while in others the reverse is true. Memories of most painful experiences may in the course of time become pleasant in retrospect.

Relation of learning to feeling. — The relation of feeling to the learning process has already been mentioned. Fundamentally, feeling is an index, as has been said, of acceptance or rejection. What is pleasurable is persisted in, what is unpleasant is refrained from. Some lines of activity are pleasurable for their own sakes, but if associated with stronger unpleasurable experiences the effect is to make the person refrain from them. On the other hand, associating the task that is inherently disagreeable with pleasurable experiences makes the repetition of the task so much

the easier. Herein lies the whole value of reward and punishment in education.

Emotions are more complex attitudes. — Of still greater significance for the mental life is that group of complex attitudes known as emotions. These comprise such experiences as fear, anger, love, hatred, sympathy, jealousy, joy, sadness, shame, and pride. These very intense experiences are closely related to the instincts that have been already described. James has shown this relation clearly in his definition of emotions: "An emotion is a tendency to feel, and an instinct is a tendency to act, characteristically, when in the presence of a certain object in the environment. The only distinction one may draw is that the reaction called emotional terminates in the subject's own body, whilst the reaction called instinctive is apt to go farther and enter into practical relations with the exciting object."

Relation of emotion to its motor accompaniments. — Every emotion carries with it instinctive bodily responses, which we call in every-day speech expressions of the emotion. Thus in fear there is momentary slowing of the heart-beat, followed by very rapid heart action; the breathing is affected; the limbs tremble; the face grows pale; the person may run or on the contrary be unable to do so, and there is a contraction of the muscles of the stomach. Any one or more of these responses, except probably the last, may be absent, or at least scarcely noticeable; but there is al-

ways present the characteristic feeling of disturbance located at the pit of the stomach.

Now, this characteristic feeling in the stomach constituting the core of the emotion is, like the other effects mentioned, caused by the motor effects of the exciting situation. Like the changes in the heart-beat and breathing, it is caused by muscular contraction within the bodily organs. The motor discharges causing these contractions do not result in outwardly observable changes in behavior, such as running away, or trembling, or lack of control of the speech muscles, but like the latter they are reported to consciousness and together with them produce the wide-spread effects that are felt as the emotion. The fear is the feeling of the wide-spread motor effects of the exciting situation in various portions of the body. Thus the fear does not cause the expressions of fear, as popularly supposed. It would be much nearer the truth to say that the emotion is caused by the muscular responses in the body. This view has been forcibly though with exaggeration expressed by James in his frequently quoted passage: "We feel sorry because we cry, angry because we strike, afraid because we tremble."

Educational significance of emotions. — The educational significance of this doctrine is clear, and cannot be expressed better than in the following quotation from James:

Every one knows how panic is increased by flight, and how the giving way to the symptoms of grief or

anger increases those passions themselves. Each fit of sobbing makes the sorrow more acute, and calls forth another fit stronger still, until at last repose only ensues with lassitude and with the apparent exhaustion of the machinery. In rage it is notorious how we "work ourselves up" to a climax by repeated outbreaks of expression. Refuse to express a passion and it dies. Count ten before venting your anger, and its occasion seems ridiculous. Whistling to keep up your courage is no mere figure of speech. On the other hand, sit still all day in a moping posture, sigh and reply to everything with a dismal voice, and your melancholy lingers. There is no more valuable precept in moral education than this, as all who have experience know: if we wish to conquer undesirable emotional tendencies in ourselves, we must assiduously, and in the first instance cold-bloodedly, go through the outward movements of those contrary dispositions which we prefer to cultivate. The reward of persistency will infallibly come in the fading out of the sullenness or depression and the advent of real cheerfulness and kindliness in their stead. Smooth the brow, brighten the eye, contract the dorsal rather than the ventral aspect of the frame, and speak in a major key, pass the general compliment, and your heart must be frigid indeed if it do not gradually thaw.

The function of emotions. — One is naturally led, by the fact that emotions need to be curbed and modified, to ask what is the function of the emotion? Are emotions ever serviceable or should they be repressed altogether? The answer to these questions occurs at once to everybody. We do not admire the person who

is absolutely cold and indifferent to the life of feeling. It is generally agreed that such emotions as love and sympathy should be cultivated, while hatred and envy should be repressed. It is generally admitted that there are occasions for anger and pride, even though these occasions are rare.

The truth seems to be that the emotions, together with the instincts, have survived as mental functions because of their racial utility. They are capacities that have arisen in response to the necessity for immediate and energetic response. The emotions represent a sudden check to the onward normal flow of events to which the organism must respond at once without deliberation. Under conditions of primitive life, when man was mainly engaged in coping with the forces of nature and with his fellow man in the most direct way, some of the emotions, like anger and fear, were much more useful than they are to-day, when all of our relationships to objects and persons are of a less direct kind. As society became more organized, on the other hand, those emotions that tend, like love and sympathy, to the preservation of social groups became relatively more important, and were generally recognized as worthy of cultivation. It is clear, however, that the emotional reaction under conditions of civilized life finds its chief utility in the energy which it supplies for action, while its chief danger is in the immediacy of the action. Under the stress of emotion a man may accomplish prodigious feats of strength and

endurance, but he may also do prodigiously foolish things. Blind, non-deliberative action is not suited to conditions of modern society. The life of feeling must be subordinated to that of intellect.

The child's emotional life. — The emotional life of the child needs the wisest and most sympathetic oversight. Evidence accumulates that emotional strains are among the most frequent causes of disturbance in the mental life. The sensitive boy subjected to shame at the hands of a thoughtless teacher may have his school career wrecked, or at least he may accomplish little until put under the direction of a new teacher. Sheer repression of the instinctive emotional tendencies, which are deep-seated racial reactions, often leads to disastrous results. What is needed in such cases is that the situation be frankly faced and the pent-up emotional channels given an outlet in some direction that is useful rather than harmful.

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CHAPTER XI

VOLUNTARY ACTION

Involuntary action. — In the introductory chapter the fundamental principle was laid down that consciousness is a function of the organism that is used in adapting it to its environment. In each succeeding chapter the attempt has been made to show how the various kinds of conscious processes are accompanied by characteristic forms of action. It has been shown that we start out with a native equipment of automatic, reflex, and instinctive activities made in response to certain of the objects and situations that we perceive.

These native activities are modified to a greater or less extent, and at the same time habitual ways of action gradually develop for other situations and objects for which we have at first no definite modes of response. Instinctive and habitual forms of action, though quite different in their origin, are in some respects quite similar. Both classes of action are very immediate and direct responses to the stimulus that prompts them. Because of this fact these forms of behavior are sometimes called *involuntary*.

Involuntary action referred to the bodily self. — It has also been shown that in the case of reflex and auto-

matic actions consciousness plays little or no part. In the case of instinctive activities there is often present, as a part of the stimulus to action complex, bodily sensations that "urge" us on to the execution of the act. These sensations, being recognized as coming from bodily conditions, help to give the instincts their involuntary character, since they are recognized as belonging to the bodily self rather than that higher self the conceptual development of which was traced in a preceding chapter.

Involuntary action frequently accompanied by feelings and emotions. — Furthermore, instinctive actions are usually accompanied by those complex forms of consciousness that we call emotions, and the observable outward action is only a part of the motor reaction. The inner bodily responses constituting a part of the emotional expression are, as we have seen, very important parts of the total reaction.

In contrast with the strongly emotional tone of most instinctive action stands the pale and neutral character of many perceptual habits. Simple feelings of satisfaction and dissatisfaction play their part in the development of these, and in some cases pleasure and displeasure are marked accompaniments of response to habitual situations. In many other cases the perceptual response, however, is so devoid of feeling tone that in this respect they seem to be much more nearly allied to the pure reflexes than to the instincts.

Voluntary action. — With the advent of ideas the

relationship of consciousness to action becomes much more complicated, and a type of action arises that, in contrast with the simpler forms of action, we call voluntary. If we followed our ordinary way of speaking of them, voluntary actions would be defined as actions that are willed. But to speak of an action as due to "will," or, as it is frequently put, "will power," is highly objectionable from a psychological point of view. What we need to know is what "will" is and how willed acts differ from others that are not willed.

Purposefulness of voluntary action. — One of the first answers that come to the latter question is that voluntary acts differ from involuntary in the forward-looking attitude of mind that is taken when they are made. Voluntary action is purposeful action; that is, it contemplates the end of the action before it is made. We have already learned that this forward-looking tendency is made possible by means of the capacity that man has of forming ideas. We have also seen that ideas, while they are related to past sensory experience, are not forced upon us by environmental conditions at the moment of our experiencing them, but are in large measure our own constructs. Because of these characteristics, behavior in response to ideas is regarded as being much more truly an expression of our *real* selves than in the case of involuntary actions, which are in a sense forced upon us by environmental conditions.

Ideas often inhibit one another and delay action. —

There are still other reasons for this feeling of freedom that usually accompanies voluntary action. Ideas are seldom in consciousness singly, and the presence of two or more ideas at one and the same time, instead of leading to action, may lead to the deferring of action, at least as far as outwardly observable action is concerned. Such is the case in those instances that we regard as the typical instances of "will," where deliberation and decision or choice are necessary. In such cases the natural outcome in action of one idea is offset or inhibited by another. The interplay between ideas, therefore, has the useful function of blocking hasty action and of allowing consideration of the consequences of action. Every moment of ideational consciousness is likely to be a complex of ideas, each contending, so to speak, for the right of control, the result being a suspension of action until such time as one of the ideas gains the victory.

Isolated ideas issue in immediate action. — A single idea, however, has no effect of postponing action. Indeed, it is of the very nature of the idea that action should follow it, similar to that which accompanied the sensory experiences from which the idea was derived. If our minds were so constructed that ideas popped into consciousness one after the other, each idea for the time being holding complete sway, each idea would manifest itself in action in a way almost as immediate as perceptual action.

Suggestion illustrates ideo-motor action. — Condi-

tions somewhat approaching this state of affairs sometimes occur. Perhaps the most extreme cases are those occurring under conditions of hypnosis, already referred to under the head of suggestion. The most striking effect of the hypnotic condition is the increased attention of the subject to all ideas suggested by the hypnotizer and the inhibition of all other ideas. Action appropriate to the hypnotizer's ideas naturally and inevitably follows. But cases of ideo-motor action are by no means confined to abnormal conditions such as hypnosis. The well-known suggestibility of children and mobs, the phenomena of muscle-reading, ouija-boards, suppressed speech movements in silent reading, are all cases in point.

Ideo-motor action often found under normal conditions. — Sometimes the idea is of such a nature that it includes as a part of the idea itself the deferring of action until a more or less definite time in the future, a phenomenon that is both familiar and normal, as well as closely similar to post-hypnotic suggestion, described in Chapter VII. A most interesting case of this sort is one in which we successfully set ourselves to awake at an unaccustomed early hour. In a similar fashion we look ahead to engagements, the doing of errands, and similar routine activities, and when the time comes find ourselves performing them. Such evidence, together with much experimental evidence that lack of space precludes us from giving, warrants the view that all ideas, when not impeded by the pres-

ence of other ideas, work themselves out into action.

Summary of relation of consciousness to action. — The following table will serve to summarize the facts of consciousness and action that may be regarded as the basic conditions on which voluntary action is founded:

Stimulus	*Consciousness*	*Action*	
Internal condition of bodily organism.....	None	Automatic	Native
External object or situation	None or vague perception	Reflex	Native
External object or situation + or — bodily conditions...........	Perception + or — emotion	Instinctive	Native
External object or situation	Perception + or — feelings of pleasure or displeasure	Perceptual habits	Acquired
No immediate sensory stimulus but following perception or other ideas................	Ideas + or — feeling of pleasure or displeasure or emotion	Ideo-motor habits	Acquired

Voluntary decision dependent on attention. — There is no abrupt line of demarcation between voluntary and involuntary action. Ideo-motor action partakes of the nature of both. In such action there is at least some degree of purposefulness, some looking forward to the end of the action; but, on the other hand, mere presence of the idea seems to be sufficient to carry us on to the execution of the action. Voluntary action of the complete sort, however, arises when two or more of the tendencies to action enumerated in our table are

present, each striving for expression. Under these circumstances a dramatic try-out of the consequences of action takes place in consciousness before action occurs. When decision or choice is reached, one of the conflicting tendencies has succeeded in crowding out the others, and at that moment voluntary action becomes ideo-motor. The preferred idea takes its natural course. Voluntary choice is thus fundamentally a phenomenon of attention.

James has graphically described what takes place in the following illustration, which makes a strong appeal to most readers:

> We know what it is to get out of bed on a freezing morning in a room without a fire, and how the very vital principle within us protests against the ordeal. Probably most persons have lain on certain mornings for an hour at a time, unable to brace themselves for the resolve. We think how late we shall be, how the duties of the day will suffer; we say, "I must get up, this is ignominious," etc.; but still the warm couch feels too delicious, the cold outside too cruel, and resolution faints away and postpones itself again and again just as it seemed on the verge of bursting the resistance and passing over into the decisive act.
>
> Now, how do we *ever* get up under such circumstances? If I may generalize from my own experience, we more often than not get up without any struggle or decision at all. We suddenly find out that we *have* got up. A fortunate lapse of consciousness occurs; we forget both the warmth and the cold; we fall into some revery connected with the day's life, in

the course of which the idea flashes across us, "Hello! I must be here no longer"—an idea which at that lucky instant awakens no contradictory or paralyzing suggestions, and consequently produces immediately its appropriate motor effects. It was our acute consciousness of both the warmth and the cold during the period of struggle which paralyzed our activity then and kept our idea of rising in the condition of *wish* and not of *will*. The moment these inhibitory ideas ceased, the original idea exerted its effects.

It is, of course, a mere figure of speech to say, as we did in a former paragraph, that one idea contends with another and that one gains a victory over another. In reality, the ideas are merely parts of a total complex inner condition, the material outcome of which is the balancing of muscular action until the moment arrives when attention is held by one phase of this total complex, the balance is upset, and action results. Voluntary action, in the sense of choice and decision, is thus seen to be a phenomenon of attention.

Voluntary action dependent upon involuntary.— This kind of action is, then, the goal of mental development; but it is made possible only by the original stock of instinctive activities and the perceptual habits that have been acquired. At the stage where action is under the guidance of ideas a certain self-sufficiency is attained which makes possible what we call self-control; but, just as the ideas themselves have their origin in earlier sensory experiences, voluntary action

arises out of original instinctive and impulsive tendencies. One cannot perform an entirely new act by sheer force of "will."

Let any one who has not already learned to do so try to move the ears. The muscles to perform this action are there, but they will not respond. Only a great deal of effort, resulting in wide-spread movement in the muscles of the face and scalp, will bring even approximate success. But with repeated effort there arises an idea of the way "it feels" to move the ears, and after much practice the movement of the ears can be made without the accompanying scalp and face movements. Voluntary control takes place after a series of efforts which may be conveniently described as "trial and error learning." The many activities that follow what we call "willing" are made possible only because of our native equipment of activities and the subsequent learning process. "Will" turns out to be not some mysterious power that comes suddenly into existence, making the action possible, but merely a name for a present capacity that has its roots in the past.

Deliberation is a mental review of the effects of action. — Even at the perceptual level of activity, tendencies to opposed activities at one and the same time may manifest themselves. Titchener illustrates such tendencies by citing the case of the young child confronted by a strange dog. Under such circumstances "the impulse towards . . . and the impulse away

from are realized in quick succession. The child goes up to the dog, runs back to its father, approaches the dog again, and so on." Adults often catch themselves starting to perform one of two incompatible actions and then suddenly abandoning it to perform the other. But deliberation is very different from the outcomes of two conflicting perceptual tendencies like those just described. In deliberation the first most notable fact is the checking of outward action and the substitution in its place of a series of associated ideas, the consequences of which are mentally reviewed and the worth of which is tested in the light of the whole personality. The effect is a substitute for actual trial of the motor consequences of each without the necessity of really performing the action. In so far as the matters involved are of a purely intellectual sort, we have here in deliberative action exactly the conditions already described under the head of "Thinking."

Moral choice. — In other cases, however, deliberation involves not merely the consideration of which is the more logically correct of two or more possible decisions, but which is the *better* line of conduct. The most striking examples of this type of deliberation are those cases that involve moral choice. Here we find the most complex situations of all, with the various conflicting tendencies of our nature each clamoring for expression.

Necessity for choice due to conflict of desires. — We commonly speak of these experiences that call for moral choice as being due to the conflict of desires. It

will pay us, therefore, to examine what is meant by desire.

When we think of an action as taking place and resulting in pleasure and satisfaction to ourselves, we are said to desire. Sometimes the desire is said to be for objects, but in this case the meaning is obviously that the desired object should be used. In these cases, too, the satisfaction is contemplated as being attached to the outcome of some action with respect to the desired object. Desires are first of all manifested in connection with instinctive and habitual forms of response that are associated with immediate satisfactions. But with the growth of experience more and more value is placed on ideal forms of satisfaction, which can be obtained only by the denial of the immediate satisfaction.

Formation of ideals. — With the growing conception of self a sort of hierarchy of desires is arranged, representing by its arrangement the value attached to each as expressive of the true nature of the self. In this way are developed those more or less constant rules of conduct called ideals, which usually represent the aims approved by the social environment in which we live.

The "self" in moral choice. — The following quotation from Stout describes the way in which the conception of self influences moments of decision:

Voluntary action does not follow either of the conflicting tendencies, as such; it follows our preference of the one to the other. . . . The alternative is not

"this" or "that," but "shall *I* do this?" or "shall *I* do that?" Each line of action, with its results, is considered not in isolation but as part of the ideally constructed whole for which the word "I" stands. The impulse of the present moment belongs to the Self of the present moment; but this is only a transient phase of the total Self. If the impulse is realized the completed action will take its place as a component part of the life-history of the individual. He may live to regret it. In his present mood, with bottle and glass before him, he may desire to get drunk; but sobriety may have been the habit and principle of a lifetime. If he yields to temptation, the remembrance of the act will stand out in painful conflict with his normal tendencies. He will be unable to think of it without a pang.

This incompatibility between the normal Self and the present impulse, if vividly enough realized at the moment of temptation, will restrain him from drinking. If it is not sufficient, further developments of the conception of Self may be more efficacious. He may think of himself as churchwarden or elder; he may think of the ideal aspirations of his better moments; he may call to mind the thought of himself as reflected in other minds,—the dead friend who expected so much from him, and who would be so shocked at his lapse,—the talk of the general public conceived as pitying, contemptuous, or malicious. He may even consider how he would like to look back to such an episode on his death-bed.

Obviously, this detailed development of what is included in the man's conception of himself as a whole might go on interminably. As a matter of fact, it is possible that it would not be needed at all. He might

simply say, "What! *I* do such a thing? How could the thought ever have occurred to *me?*" In this case the mere concept of the Self in its vague totality without detailed development would be sufficient to produce a decision. The thought of *getting drunk* attracts the man; but the thought of *his* getting drunk repels, so as to give rise to instant rejection of the suggested course of action.

Inhibitions to voluntary action. — Since voluntary action is expressive of developed personality, it follows that the child's capacity in this respect is at first weak, and that ideals, persistence, and character are the results of gradual development. Ordinary observation shows the truth of this statement, which may be supported by evidence of detailed observation.

One line of such evidence is concerned with the so-called inhibitions of childhood. These curious blockings of voluntary endeavor, which are by no means entirely confined to childhood, are frequently associated with emotional strains. Meumann gives an example, directly concerned with the school life of a child, which is sufficiently typical of what occurs in some instances to make it of considerable educational importance. A child entered a new school. His former teacher, having an antipathy for the thirteen-year-old boy, introduced him to the new teacher, at the same time taking occasion to denounce his character. From that moment on the boy became depressed in spirits,

his school work deteriorated, and at the end of the year he was not promoted. His parents decided to send him to a third school, where he was met by the teacher with kindness and confidence, whereupon he became one of the best pupils of the school.

Importance of the confidence born of success. — Every teacher of experience knows of similar cases, where pupils fail to do the work they are capable of in one or more branches of study because of early failure or a wrong start. The maxim "Nothing succeeds like success" is nowhere more apt than in the school work of the child. This is especially true for some pupils in the mathematical branches, where the supposed necessity for each child to cover a certain amount of ground soon takes these pupils beyond their depth, with resultant discouragement and failure. The teacher's influence on the pupil's intellectual advancement cannot meet with success unless it is accompanied by that mutual confidence between pupil and teacher and the spirit of helpfulness that makes for encouragement.

Suggestibility of children. — Reference has already been made to the fact that children are more suggestible than adults—a natural consequence of their lack of experience and of ideational control. The child's actions are determined by the situations in which he finds himself, and especially by the influence of older persons. A question, a gesture or a glance is frequently all that is necessary to bring about a certain response.

Teachers know how easy it is to evoke a wrong answer from an entire class by means of a suggestive question. The increased suggestibility due to large numbers meeting together is especially characteristic of school conditions. In this way arise school traditions and that vague but highly important feature of every school which we refer to as the "spirit of the school."

Importance of training character. — In view of this susceptibility of the child, the influence of the teacher and the parent may become almost immeasurable, and at the same time the task of training character becomes one that involves the gravest difficulties and calls for the highest wisdom and skill. As Thorndike has pointed out: "Morality is more susceptible than intellect to environmental influences. Moral traits are more often matters of the direction of capacities and the creation of desires and aversions. Over them their education has greater sway, though school education, because of the peculiar narrowness of the life of the school-room, has so far done little for any save the intellectual virtues."

The great difficulty in securing healthy development of character comes from the fact that the possibility of greatly influencing the child's behavior comes from a weakness of the child's character. The child must be taught to think for himself and develop independent judgment. This necessity is as great in the moral as in the intellectual sphere. How to develop this ini-

tiative, and at the same time not lose the opportunity of molding him in the right way during the plastic period, calls for the highest wisdom at our disposal.

Training the will dependent on habit. — Training the will means, fundamentally, developing habits of action that conform to the best ideals of society. As we have seen, the "will" is powerless unless it has at its disposal either instinctive or habitual modes of action with which it may work. It is true that under the stress of emotional appeal, as in the case of religious revivals, revolutionary changes may be made in a person's desires. But, as religious leaders well know, the effect of such conversions is temporary unless steps are at once taken to form a new group of habits conforming to the new ideas. This is the real reason why so few ideals are ever realized. It is comparatively easy for the school to create ideals through the influence of biography, literature, history, or indeed any of the subjects of the curriculum. The difficulty comes from the necessity of joining these to action, and this can be accomplished only through the slow and often painful task of habit formation.

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CHAPTER XII

LEARNING

Learning of various kinds. — The study we have made up to this point cannot fail to have shown that what we call "learning" in every-day life consists of many different psychological processes variously combined. It is true that all learning, when viewed from the standpoint of what goes on in the nervous system, is simply a process of forming connections, that is, of the organization of sensori-motor tracts; but, viewed from the standpoint of the accompanying mental processes, there are many kinds of learning.

Perceptual learning. — One of the simplest kinds of learning, psychologically considered, is that which takes place in perceptual development. This is that fundamental process of learning by means of which we come to know the world of objects with which we are surrounded. From time to time new objects are met with in our experience, but most of these objects are learned in some sense early in life, and it is only as they become better observed and their characteristics better analyzed that it can be said that any perceptual learning takes place in adult life. In these cases the learning usually takes place so gradually and

so unconsciously that it is seldom possible to describe the process in detail.

Perceptual learning in the case of an illusion. — Judd's investigation of the effects of practice on the perception of the Müller-Lyer illusion affords a useful illustration of this point. Here we have a case of perceptual learning that takes place under experimental

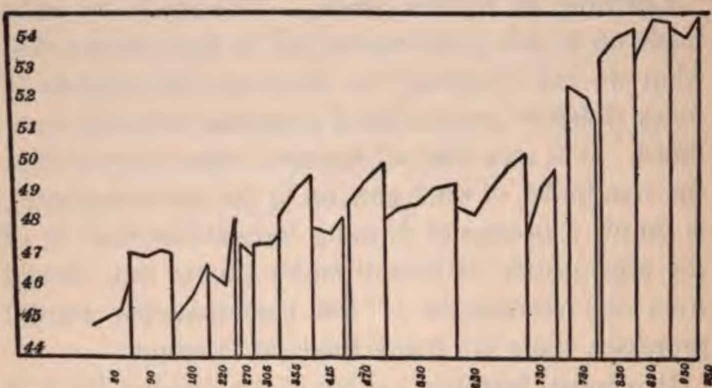

FIG. 24. Curve showing effect of practice with the Müller-Lyer illusion. (After Judd.)

conditions and in which many of the factors of the process have been analyzed and described. (See page 100.) Fig. 24 shows the effects of practice on the perception of this illusion under the conditions already described in an earlier chapter. In the experiment, the length of the standard line, that is, of the part of the figure that remained constant, was 54 centimeters long. At the beginning of the experiment the subject whose "curve of learning" is given perceived the two hori-

zontal lines of the figures as equal, when the overestimated line was only between 44 and 45 centimeters in length. At the end of the 980 trials, however, the two lines appeared equal when they were actually equal or approximately so. It will be noticed that the improvement that takes place is not uniform, but varies from period to period, and toward the latter part of the series of trials is very rapid.

Some description can be given of the way in which the learning process shown by the curve takes place. At first the subject perceives the figure as a whole in which the various lines are combined in such a way as to give rise to the illusory experience. Then begins a process of analysis in which the horizontal lines are selected for especial observation, the oblique lines being relatively neglected. Finally a stage is reached in which all of the lines are again combined or synthesized, and the whole figure takes on a new interpretation or meaning. It will be seen that fundamentally these processes of analysis and synthesis are processes of attention.

Learning through observation. — Processes of learning similar to this must be going on continually in the early life of the child and to some degree in that of the adult. Probably the child's early sensory experiences are presented to him in a more or less confused jumble, and he gradually achieves his world of objects through such processes of perceptual development, breaking this vague mass of experience into more

clearly observed parts and putting them together again in such a way as to give them meanings more and more in agreement with the demands of experience. Even in adult life the process continues. Objects are analyzed into their elements, they are observed from new points of view and are seen in new lights, whenever they are put to uses different from the ordinary, as, for example, when it is necessary to draw them. This is especially true in the case of scientific observation of objects, such as when new and hitherto unsuspected features are revealed with the aid of the microscope.

Motor processes in perceptual learning. — But this account of perceptual learning tells only one side of the story. Side by side with these sensory processes of learning, new modes of response are continually coming into play. In other words, habits are being formed. Even in the case of the illusion mentioned above, new habits of eye movement are developed, as has already been shown. The motor and sensory learning are in reality the two sides of the same process; they are separated only for purposes of description. In some cases we are able to observe the sensory processes more clearly, and in others the motor processes.

Trial-and-error learning. — The development of new ways of acting in connection with perceptual experiences is usually referred to as the "trial-and-error" method of learning, because of the relatively unconscious way in which it goes forward and because the

improvement takes place in an apparently hit-or-miss fashion. The trial-and-error method of learning is well illustrated in much of the behavior of the lower animals. If a cat, for example, is placed in a box with a door in its side fastened by a simple latch, and food is placed on the outside of the box, the cat will rush about, scratch and bite at the sides of the box. Its reactions are of a random sort, including most of its stock of instinctive and habitual actions. In the course of a comparatively long time the animal will succeed, apparently by accident, in making the movement necessary to open the door and escape. If replaced, the cat goes through virtually the same performance; but if placed again and again in the box, the time required for it to escape is gradually reduced, and finally it learns to make the appropriate movement at once without any preliminary useless movements. This process, in which the useless movements become gradually eliminated and the successful movements preserved, is typical of the way in which much of man's learning to make responses to new situations takes place. In the case of man, however, this type of learning is usually complicated to some degree with other kinds of learning, which will be described later.

Human learning complex. — Random movements, many of which are useless for the purpose, the gradual disappearance of the useless movements, and the "stamping in" of the successful reactions are typ
such human learning as riding a bicycle, play

or writing. An easily performed experiment that will illustrate this type of learning is that of mirror-drawing. Place a drawing, such as that of a six-pointed star, in front of a mirror, and attempt to trace the lines of the star while looking at the hand and drawing as they appear in the mirror. A screen should be

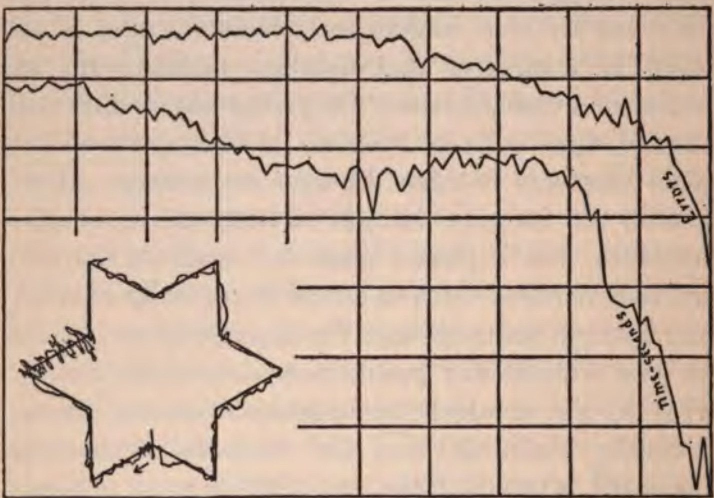

Fig. 25. Curves of learning in mirror drawing. (After Starch.)

used to shield the hand and drawing from direct view. The person making the drawing should return to the line he is attempting to trace as soon as the pencil is found to leave it. Here we have a situation that is so novel as to require the learning of a new habit to meet it. No mere effort of will can bring about the successful action. It must be learned by a gradual process

in which all of the features of trial-and-error learning already mentioned are present. Fig. 25 shows the results of training as measured both in time and errors made during a long period of practice. The star in the corner of the figure gives an illustration of the incoordinated movements necessary at an early stage of practice.

Very little of man's learning can be described as being based on a method of pure trial and error, in which the progress takes place, as it were, accidentally or at least without conscious direction. Thus in learning to play golf few persons, even when beginning to play the game, simply swing at the ball with the club in a hit-or-miss fashion, keeping it up until the efforts are crowned with success. The usual procedure is rather to begin under instruction from an expert or from one who at least knows something of the way in which the strokes should be made. Under these conditions the learning is more than a mere series of total responses to a gross situation. The situation is analyzed into component elements and corresponding movements. Thus one is instructed to keep one's eye on the ball until after it has left the club, to place the feet and body in a certain position with reference to the ball and its line of flight, to raise and lower the club in a particular manner, etc. Each one of these actions must be attended to more or less separately and in a certain order, and yet be combined into a coordinated series of acts. Even under these ci-

stances, however, the learning of the separate responses and the fitting of them together will require much of the purely trial-and-error method of learning.

Ideational learning. — In learning of this kind the analysis is ideational. The ideas in the instructions are worked out in advance of the actual performance of the movements. The selected elements, with their responses, are reviewed mentally, with the result that a short cut is made in the learning. Often, when the constituent elements of the situation and the motor response are already well known, the imparting of ideas through instruction may save the learner from all necessity of trial and error and the performance may be correct the first time it is tried. Thus, to take a simple example, one may learn from a policeman, when visiting a strange place, the way to the post-office and direct his steps successfully on the basis of the ideas acquired.

Illustration of complex human learning. — The learning of complex activities involving trial-and-error, analysis, and ideational guidance has been made the subject of considerable psychological investigation. One of the most enlightening of these studies is that made by Bryan and Harter on learning telegraphy. Learning telegraphy is like learning a new language and translating it into the native tongue as far as the receiving of messages is concerned. In the sending of messages the motor processes of hand and arm in pressing the key are analogous to the oral ex-

pression of ordinary language, or still more nearly analogous to handwriting movements, made in response to dictation. Let us consider the sending side of the learning of telegraphy first. Bryan and Harter found that the learning takes place by the acquirement of habits, some simple and others complex, or, as they put it, lower and higher orders of habits. The beginner starts by learning the alphabet of dots and dashes, slowly spelling out each word as he presses the key in the appropriate way. The next stage is reached when he is able to associate the movements necessary to send entire words in a unitary series, just as we do in speaking. The letters and their corresponding movements are no longer attended to separately, but the dots and dashes as heard and the movements necessary to make them are run together into a single unit. Such habits are habits of a higher order than those that the beginner first learned. Progress continues until words, especially those that frequently occur together, are combined into still larger units, constituting a third and still higher order of habits. The upper curve of Fig. 26 shows the gradual improvement in sending, relatively rapid at first and slow towards the end, and fluctuating from period to period.

Learning to send telegraphic messages is at first easier than learning to receive, though in the long run the capacity for receiving outstrips that for sending. In sending, the operator looks ahead as we do in reading, and at the same time determines the rate at his

own convenience. In receiving, however, looking ahead has to depend entirely on the imagination, and it is found that mistakes are made in this way. Accordingly the expert telegrapher, in receiving, not only does not look forward, but actually lets the message get ahead of his receiving. When writing or typewriting

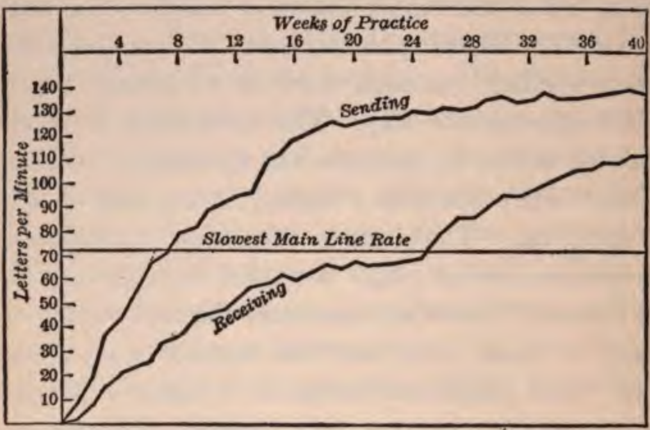

FIG. 26. Curves of learning to send and receive telegraphic messages. (After Bryan and Harter.)

the message, he waits until he is from six to ten words behind the instrument before beginning to transcribe the message. The units of perception are so large that he is able to do this, and the liability to make mistakes is lessened. The lower curve of Fig. 26 shows the curve of learning for receiving telegraphic messages.

Plateaus in the learning curve. — This curve is especially interesting because of certain features com-

mon to many learning curves in other investigations but not present in the learning curve for sending messages. It will be seen that, besides the general features noted above in connection with the curve of sending, there is a point near the middle of the curve where progress ceases for some time, after which a sudden improvement takes places. Such parts of learning curves, indicating no gain and suddenly followed by rapid improvement, have been designated "plateaus."

Such periods of depression in the various forms of school-room learning can be testified to in the experience of most pupils and teachers. In the learning of any subject progress is relatively rapid at first, but there frequently comes a time of stagnation with most discouraging results for all concerned. With persistent application this period passes over to one of rapid progress comparable to that with which the learning began. The question of interest is, whether such periods of lack of progress are necessary and to what they are due. The first obvious suggestion in answer to the latter question is that the retarded progress is due to loss of interest. But, while this may in some cases be a factor, the plateau frequently occurs without any such feeling on the part of the learner, and without any feeling of renewed interest at the point at which the sudden gain makes its appearance. Most investigators agree that the latter point is reached when new methods begin to be used. The plateau represents a point where the limit of progress has been made until

some new mode of attack upon the situation has been devised or hit upon.

Explanation of the plateau. — In the special case before us Bryan and Harter have explained the plateau period in a manner that can be clearly understood by a reference to Fig. 27. This figure gives separate curves

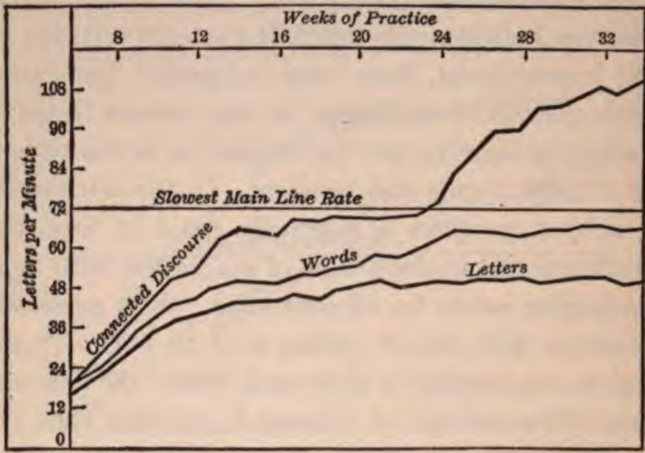

FIG. 27. Separate curves of learning for letters, words, and connected discourse in receiving telegraphic messages. The uppermost curve is the same as the lower curve in Fig. 26. (After Bryan and Harter.)

for the progress in each of the three orders of habits referred to above. It will be seen that the learning for words and letters reached the limit of improvement at about the time that the learning for connected discourse was recovering from the plateau period. The explanation seems to be, therefore, that the plateau represents a period of only apparent lack of progress—

a period in which habits of the lower order are being perfected—after which these habits are made available for the rapid progress in the higher order of habits. The plateau period turns out to be a necessary period of preparation for a fresh start according to a new method through the incorporation of the lower orders of habit into that of the higher.

Learning through association. — A very great deal if not most of the learning of the school-room consists in memory of the associative type. This type of learning was among the first of psychological processes to be investigated by experimental methods, and much light has been thrown on the subject by the results of this experimental work.

The earliest work in this field was done by Ebbinghaus, a German psychologist, who used nonsense syllables as materials for learning. These nonsense syllables were made up of vowels and consonants in such a way as to make pronounceable words, but so as to have no meanings (for example, *zef, tos, pem*). The advantage of the use of such words is that the learning of one series of a certain number of nonsense syllables under certain conditions may be directly compared with the learning of a second series of the same length under different conditions. Since the words are devoid of meaning, the learning process is reduced to the purely mechanical association of each word with the others of the series.

Effects of repetition. — One of the problems that

Ebbinghaus set himself was to discover the effects of different numbers of repetitions on the amount remembered. He learned one series of sixteen syllables so that it could be said once without mistakes. A second series was learned in the same way and then repeated eight additional times. Still other series of the same length were repeated sixteen, twenty-four, up to sixty-four times after they were just learned. He found in this way that each repetition after the first learning had practically the same effect, resulting in a saving in the time for relearning twenty-four hours afterward of about twelve seconds per repetition. The following table gives the results in detail:

Repetitions	*Time for Relearning*	*Time Saved*	*Time Saved per Syllable*
0	1270 seconds		
8	1167 "	103 seconds	12.9 seconds
16	1078 "	192 "	12.0 "
24	975 "	295 "	12.3 "
32	863 "	407 "	12.7 "
42	697 "	573 "	13.6 "
53	585 "	685 "	12.9 "
64	454 "	816 "	12.8 "

By a similar method it was found that the rate of forgetting is very rapid at first, then decreases, and finally a small amount remains that is remembered almost indefinitely.

Learning beyond the threshold. — As stated in the last paragraph, Ebbinghaus regarded a series of nonsense syllables as having been learned when it could be repeated once without mistakes. We may call the

point in the learning process where this can be done the threshold. While the method used by Ebbinghaus is well adapted to his experimental purposes, it is easy to see that learning merely to the threshold does not meet the requirements of most school purposes. Ebbinghaus found that a very large part of what he had learned in this way was forgotten one hour afterward. Hence the necessity that arises of carrying the learning beyond the threshold so as to forestall the effects of forgetting. The youthful mind is apt to assume that permanent results have been attained long before there is sufficient warrant for thinking so. How much repetition is necessary in any particular instance is, of course, difficult to determine. It will differ with the individual learner, the subject of study, and the degree of permanence necessary. Every student, however, should know the importance of this principle and seek to learn from his own experience how to put it into effect.

The will to remember. — It is obvious that the learning process is made easier by concentrating the attention on the material to be learned. One rule, therefore, for easy and efficient learning is that the learner should be interested in what he is doing. It is too much to expect that the learner should always be interested in the material to be learned for its own sake. No one could be interested, for example, in the learning of nonsense syllables simply for their own sake. Where interest is not present immediately, it

becomes necessary to introduce motives that lie outside the material itself—the desire to excel, to please others, or other factors that we have found to be characteristic of voluntary attention. Striking evidence of the effect of lack of concentration in learning may sometimes be obtained from laboratory work in memory. A number of experimenters have reported, for example, that they have repeated a series of nonsense syllables to a learner a sufficient number of times for the latter to memorize them, and then the same series again to a second learner, and still a third, without being able to remember the series themselves.

In such instances it is probable that the failure to remember material that has been so frequently repeated by the experimenter is in part due to another important factor in the learning process, which may be easily overlooked by the student in actual practice. This factor may be expressed by the phrase "the intention to remember." It is found that the learner of a series of nonsense syllables remembers it much better if he has more or less definitely before his mind the subsequent testing that is to take place. If the learner thinks the material is to be learned for temporary purposes and is afterward tested, it is found to be less well remembered later than when he learns with the expectation of being tested some time afterward, even though the amount of time devoted to the learning is the same in both cases and the results are similar for the first learning. Hence the learner should

look ahead to the occasion when the material being learned is to be used. Even when the occasion for use is not a definite one, the anticipation of possible occasions for its use is helpful in preventing that forgetting which is the ordinary outcome of those experiences that seem to have no significance.

Using what is learned. — The question of actual use of what is learned is highly important in connection with learning. We know and remember best what we use most. The recitation, the test, the examination find much of their justification because they furnish not only reviews but opportunities for the pupil to use what has been learned. Where opportunities for use do not occur naturally, they should be sought for and created. The person who has a great fund of anecdotes to relate is the one who is always buttonholing his friends and telling his latest story.

Distribution of learning periods. — Ebbinghaus learned series of nonsense syllables by two different methods, his purpose being to determine whether it is better to learn the material up to the time it can just be recited and then continue to repeat it for a considerable period, or to distribute the same amount of time over a number of learning periods with intervals in between. A series of syllables was learned so that it could be repeated correctly after 17 repetitions, after which 51 more repetitions were made in order to fix it in memory. As a result of these 68 repetitions enough was remembered twenty-four hours

later so that the series was relearned with 7 repetitions. A second series of the same length was repeated 18, 13, and 7 times on each of three successive days. As a result of this total number of 38 repetitions, only 5 repetitions were necessary to relearn the series twenty-four hours later. Hence the principle arises, which has been confirmed by a number of other investigations both with nonsense and significant material, that it is better to distribute a given amount of learning time over a number of periods than to do all of the learning at one time. This result is not entirely due to the effects of fatigue in the longer period, for it has been shown to hold under conditions where fatigue could not enter as a factor. Apparently what has been learned continues to become fixed even after the conscious attention to the learning has ceased—a phenomenon very much like that which appears in connection with the plateau period in the learning curve, which has already been described. The student who does all his learning at one sitting fails to take advantage of this unconscious assimilation.

Experimental evidence needed of best periods of distribution. — The principle just discussed has an important bearing upon the making of school programs—the number of recitations per week for each subject and the length of time over which the study of any one subject should be extended. There is some reason to believe that some of the subjects of the high school, which are commonly pursued for each day in the week

for a year and then dropped, might be taught more advantageously if given on alternate days for a period of two years. Unfortunately, there is no experimental evidence to confirm or deny this view.

Understanding what is learned. — Ebbinghaus found that he could learn connected words that had significance eight or nine times as fast as nonsense material. The element of meaning is, therefore, the most important single factor in the learning process. To understand the material to be learned becomes the most important rule for learning, for two reasons: (1) because only when it is understood can it efficiently be used; and (2) because the better understood it is, the more economically it can be learned.

Any plan of procedure, therefore, that leads to an attitude of active inquiry as to the bearings and significance of what is being learned is found to be fruitful in results. Some lessons, for example, can be learned more easily if they are first read through somewhat hastily for the sake of getting one's general bearings. In the later more thorough study each detail is seen in its proper setting and is more easily understood and remembered.

Again, most lessons are in reality composed of series of problems with their solutions. They present situations that demand the kind of treatment described in the chapter on "Thinking." Many students fail to realize this aspect of the study problem in connection with subjects other than mathematics. If the

student will ask himself what problem the author of the text is raising as he proceeds in his work, and will think out the solution to the problem along with the author, the task of remembering will become relatively easy. Better still, if he can raise other problems suggested by those of the book, and can solve them from his own experience or by going to other sources of information, study will become both easy and profitable.

Learning by wholes and parts. — Where material is to be learned *verbatim* it is possible to take either one of two methods. In the first place, it may be learned by repeating over and over parts of the material until each part is thoroughly learned, and then proceeding to learn the next part in a similar manner. In learning poetry, for example, the part chosen may be a single line. The second method is that in which the learner proceeds by reading over the entire selection and then repeating in the same way until it is learned. Pupils naturally follow one or the other of these two methods, usually the former, when left to themselves.

Careful experiments have shown, however, that the method of learning by parts is less economical than that of learning by wholes. Various reasons may be offered for the superiority of the latter method. In the first place, the material that is read over in its entirety is better understood than when attacked in parts, thus making the learning less mechanical and giving the benefits that we have seen are to be derived from

forming thought connections. Again, in learning by parts the associations set up are in part incorrect, and have to be in time broken up. Thus, in learning line by line the first lines of Longfellow's "Hymn of Life,"

> Lives of great men all remind us,
> We can make our lives sublime,

an association is set up between "us" and "lives" instead of between "us" and "we." Eventually the former association must be broken up and the latter established.

However, the method of learning by wholes must not be pushed to the extreme of repeating the entire selection over and over again merely because a few more difficult parts are not yet thoroughly learned. These more difficult portions should be learned separately. It is also evident that some selections may be too long to be learned in their whole length. In such cases the material may be broken up into smaller wholes, although it is probably always an advantage to read the entire selection at least once for the sake of the aid such procedure gives to understanding the thought.

The method of learning by wholes is not always advantageous in the case of those who have been used to learning by the other method. In changing from one method to the other, in some cases there seems to be some loss; but it is believed that with practice such individuals will find the whole method more effective. Even though there may be in som

uals a marked preference for the part method, the experimental evidence shows clearly that for the majority of individuals the method of learning by wholes is much superior.

Modes of impression and recall. — Still another problem of memory concerns the relation between the various modes of recall and the modes of impression. Virtually all of the material to be learned in connection with school work may be made through visual or auditory or kinesthetic impressions, or by two or all of them combined. Now, in recalling, the form of imagery preferred varies from one individual to another. It has generally been held that a person who recalls by preference in the form of visual imagery will, for that reason, remember more effectively if the original learning is made through visual impressions. This view of the matter has not been confirmed experimentally. It appears rather that any sort of original impression may usually be transferred easily into the preferred form of imagery for purposes of recall. In cases where ordinary methods do not bring the desired results, however, it is always to be suspected that very decided preferences for one-sided forms of imagery are present, and methods of presentation should be varied to suit the individual case.

One pedagogical device for obviating the difficulty arising from individual differences where pupils are taught in classes is the method of so-called "multiple-sense appeal." By this method all material is learned

through as many sense avenues as possible. In this way pupils may have their preferences allowed for in at least a part of the instruction. At the same time, the multiplicity of association creates a greater possibility of successful recall. In this connection it may be well to repeat that the various types of mental imagery may be cultivated, and in special cases this form of training may be resorted to. The experimental evidence seems to show that the visual form of recall is more accurate but less rapid than the auditory.

The principle of recall. — As soon as any material that is being studied begins to be fairly well learned, it is advantageous to try to recall it without the aid of the book. The recall of the subject matter of study under these conditions helps to show where the greatest emphasis should be put on the subsequent learning. The effort required to recall makes for concentration and affords an opportunity for the student to anticipate how his mind will work when the teacher questions him or he is otherwise tested. Under such circumstances associative aids are likely to be formed that will be found to be of much value later on.

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CHAPTER XIII

TRANSFER OF TRAINING

The problem of formal training. — A problem of considerable importance to educational theory and practice is raised when one asks the question: "Does the increased efficiency caused by learning in one subject give increased efficiency in others?" For example, does the study of Latin merely give knowledge of Latin, or does it train the mind so that it has an increased capacity for other subjects as well?

One view is that all training is general. — Two opposed views have been held in answer to this question. According to one view, all learning is *general* in its effects. The mind is trained by exercise, just as is the body; or, if not the mind as a whole, certain general capacities of the mind, such as memory or observation or reasoning. Probably most persons assume that the pursuit of any school subject results in training the mind as well as in giving the pupil information about that particular subject. The claim is often made that Latin is good discipline, that nature study cultivates powers of observation, that geometry develops reasoning ability, the idea in each case being that the effects of the learning are not limited to the particular study, but are general.

The view that training is specific. — On the other hand, there are those who hold that all learning is *specific* in its results, that is, it is confined in its effects to the particular kind of situation in which it was learned. Latin trains the mind for things other than Latin only in so far as Latin is related to these other things—as, for example, English. The training of observation in nature study increases capacity of observation for natural objects, but not for other things, such as people's faces or pictures. While a person may be trained by the study of geometry to reason mathematically, he will reason no better on that account in matters of politics. Ordinary observation shows that such capacities are not general. Thus, a person may be neat in dress, but not neat in other respects; he may have a good memory for faces, but a poor memory for names; one may be accurate and precise in the use of English, but quite the reverse in mathematics. In short, there is reason to believe as has been stated by Thorndike, that "training the mind means the development of thousands of particular independent capacities, the formation of countless particular habits."

Can memory be trained? — Take the case of memory. Is it true that memory in general can be trained by practice? William James attacked this problem in what was at that time a novel manner. Since memory is primarily a matter of retention, he held that it is dependent upon the original plasticity of the nervous

system, and therefore that it could not be improved by practice. James explained those cases in which improvement of memory by means of practice seems to take place by saying that such improvement is due to improved methods of learning, rather than to any improvement in the retentive capacity. It is a well-known fact that persons who have a great deal of memorizing to do become very proficient. It is no uncommon matter, for example, for a stock company of actors and actresses to be playing one play, rehearsing a second, and learning a third each week.

In cases like these James believes that facility is acquired by the building up of many associations and thus increasing the possibility of revival, and by the development of habits of attention and thought that make the learning easier and the recall surer. What appears to be improved memory is in reality the acquiring of better habits of learning.

An experimental attack on the problem. — In order to test his conclusion experimentally, James practised his memory by learning the entire first book of Milton's "Paradise Lost." Before beginning this practice, however, he tested his memory by finding out how long it took him to learn 158 lines of Victor Hugo's "Satyr." Again, at the end of the practice with "Paradise Lost" he tested with 158 lines of the "Satyr," and found no improvement over his earlier memorizing.

This experiment made by James, and those of some of his students made at the same time, were somewhat

inconclusive because of differences in the results and because of very evident faults in the methods of carrying out the experiments. James himself admits, for example, that he was "perceptibly fagged" when he tested himself the second time on the "Satyr." Since that time, however, large numbers of experiments made in a similar way but with greater refinement of method have been carried out not only concerning memory but in many other fields.

Further experimentation. — Ebert and Meumann attempted to discover to what degree memory may be generally improved by practice in memorizing nonsense syllables. Before beginning the practice they tested the ability of those taking part in the experiment to remember numbers, letters, geometrical forms, German-Italian vocabularies, poetry, prose, etc. At certain intervals during the practice period with the nonsense syllables and at the end of the experiment they were tested again with numbers, letters, etc. It was found that improvement took place in memorizing the nonsense syllables to the extent of 70 per cent. At the same time an improvement of from 11 to 81 per cent took place in memorizing the other sorts of material that had not been directly practised.

In general the larger degree of improvement in the test series was in the material most like nonsense syllables. Thus, the gain in remembering numbers was 60 per cent, while that for poetry was only 11 per cent. Other experimenters have shown that Ebert

and Meumann's percentages of gain in remembering the material not directly practised are too high, because the tests themselves afforded some opportunity for practice. Dearborn has shown that persons taking tests just as did Ebert and Meumann's subjects, but without any training series at all, nevertheless improved to an average amount of 32 per cent. The true gain made by the effects of training is, therefore, considerably less than the amount of Ebert and Meumann's figures.

Rugg's experiments. — Rugg investigated the effect of a semester's training in descriptive geometry on the capacities of students taking the course. The problem was to discover whether this training was limited in its effects to the subject studied or whether there was a spread or "transfer" of effects to other capacities. His experiments included tests of two groups of students, the "training group" (those taking descriptive geometry) and the "control group" (those not taking descriptive geometry). Both groups took certain "preliminary tests" at the beginning of the experiment and both groups took the "end tests" at its close. The preliminary and end tests were of the same sort, being designed to test capacity of visual imagination in various ways. For example, in one series of tests the students were asked to divide numbers mentally; in another they were required to picture the letters of the word "material" and to form from these letters as many new words as possible; in still another to form

a mental picture of certain geometrical objects (for example, a wedge) and to count the number of straight lines that it would take to construct one in space.

As a result of these tests Rugg found that (1) the training group taken as a whole made greater gains than the control group in the end tests as compared with the preliminary tests; (2) the training group contained a larger proportion of gainers than the control group; and (3) the training group gained in a larger proportion of the tests taken than did the control group.

General conclusions. — The experiments that have been described may be regarded as typical, both in their methods and in their results, of the large majority of investigations concerning transfer of training. Taken as a whole, the following generalizations may be made:

(1) In nearly all cases there is evidence of some degree of transfer of the effects of practice to other capacities than those directly trained.

(2) The amount of improvement effected by practice directly is almost always considerably greater than the amount of indirect or transfer effect.

(3) The amount of the transfer effect is usually greater in the case of mental capacities that are similar to those practised than in the case of those that are less similar.

The upholder of the doctrine of general training is therefore warranted in his belief that there are valu-

able by-products to be expected from proper training in any specific field of study. On the other hand, it is no longer possible to maintain that the best way of training the student for definite situations is to teach him something else. Experiment shows that when the right hand is trained to perform a certain task, the left hand shares to a certain extent in the increased power and skill; but it would be an extremely inefficient way of training the left hand to do it indirectly through training the right. The danger in holding the doctrine of formal training in an extreme form is that it leads to a blind trust in the formula "train the mind" and the specific purpose of the training is lost sight of. As will be seen in a later chapter, even such useful subjects as reading and writing are sometimes carried to unnecessary lengths because of the persistence of the belief that the constant drill is "training the mind."

Training by means of difficult subjects. — The term "mental discipline" is sometimes used with the idea back of it that education, if it is worth while, must train the pupil to do hard work. This capacity for overcoming difficulties is in large measure equivalent to giving concentrated attention to the work and persisting in doing so after the interest flags. When a task becomes wearisome there are feelings of strain and unpleasantness. Training helps the pupil to disregard these unpleasant feelings and continue the task, and there can be little doubt that such training func-

tions more or less generally. But difficult tasks should not be imposed on the student merely because they are difficult, for there are enough difficult tasks to perform that are also useful. If, at the same time, the difficult task can be made the natural outcome of an original or acquired interest of the pupil, he is relieved of drudgery without any loss of mental discipline. To the extent that the compulsion to continue his task comes from within, it results in permanent training; but if it is imposed from without it does not function unless the outward authority is present.

Negative transfer. — It has been found that under some circumstances practice in one direction may not only not bring about added efficiency in another, but may even interfere with increased efficiency in the second. For example, in the case of one of his subjects Judd found in his experiments with the Müller-Lyer illusion, already referred to, that practice overcame the illusion. When, however, the figure was reversed end for end, not only was the practice effect not carried over to this slightly different situation, but a great deal of practice on the figure in this latter form failed to bring about any improvement. As Judd points out, we see this sort of thing in every-day life, where specialization along a certain line tends to narrow the interests in that direction, and to that extent precludes the development of interests in other directions. So far from developing the power of observation in general, for example, training in observing things through

microscopes may develop observation of that sort to such an extent as to interfere with the habit of observing other things.

Conditions of transfer. — Judd's experiment with the Müller-Lyer figure shows further that whether transfer of practice effects takes place or does not may depend not so much on whether the second situation is similar to the first as on the learner's attitude toward his problem. While, in the case of the subject referred to above, there was no transfer effect from the practice with the figure in the one form to the other, in the case of another subject there was. The difference in the two cases was that the first subject knew nothing about the results of the practice. He did not know that there was an illusion to begin with, and he did not know that he actually saw the figure in a new way after practice. In the case of the second subject, however, both of these conditions were well understood.

Various other experiments tend to show that the learner's knowledge of the results of his learning and his general attitude toward the problem may determine whether transfer effects take place. Children taught to be neat in arithmetic, for example, were found in one experiment not to have acquired any more neatness in their other work. In another experiment, however, in which the conditions were slightly changed by trying to impress the "ideal" of neatness on the pupils, a general improvement in neatness re-

sulted. School life is full of situations that may lead to the cultivation of important attitudes of general serviceableness, such as accuracy, thoroughness, industry, initiative, and independent thinking.

If, then, we raise such questions as whether training in geometry develops the capacity for reasoning in general, there seems little doubt that the correct answer is that in some instances it does and in others it does not. Whether it does or does not depends on whether the pupil acquires a feeling for logical consistency which he strives to carry out in all his thinking. The skill of teachers must be largely measured by the success they have in developing such generalized attitudes in their pupils.

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CHAPTER XIV

INDIVIDUAL DIFFERENCES

Individuals differ from one another in mental capacities. — Up to this point the description given of the mental life may have created the impression that people are for the most part alike or nearly alike in their mental capacities. To be sure, it was shown in connection with the discussion of mental imagery that very important differences exist between different individuals. It was there shown that under similar objective conditions some people have a preference for the use of some one or more kinds of mental imagery, while other persons prefer a different kind. Such differences as these may be called qualitative differences, since they refer to the use of different kinds of mental processes by different persons under similar conditions. Besides the qualitative differences between individuals, there are also large quantitative differences, that is, differences in the degrees of efficiency that different persons are able to exert in using the same kind of mental capacity. Both the qualitative and quantitative individual differences are so important for education, and so apt to be overlooked in thinking and practice, that it will be well to consider them in some detail.

Individual differences in physical traits. — Individual differences in physical traits are easily observable. When measurements of such traits are made in the case of large numbers of individuals some interesting facts are revealed. The following table gives the heights of 1171 sixteen-year-old girls and the number and percentage of the whole group that have reached each height:

Table II

Height in Centimeters	*Number of Cases*	*Per Cent of Cases*
136–139	2	0.2
140–143	12	1.0
144–147	54	4.6
148–151	159	13.6
152–155	280	23.9
156–159	310	26.5
160–163	218	18.6
164–167	102	8.7
168–171	31	2.6
172–175	2	0.2
176–179	1	0.1

The curve of distribution. — These facts may also be shown in the form of a diagram (Fig. 28) called a surface of frequency or distribution curve. The horizontal base line is laid off into ten equal divisions, each of which represents one of the four centimeter units of the table. The height of the vertical line at each of the division points on the base line represents the number of cases of that height. Thus the first vertical stands for two cases, and the last, which is half as long as the first, for one case. Either the height of the various points above the base line or any one of the rectangles may be regarded as standing for the

number of individuals of the heights indicated at the base. The larger the number of individuals measured and the smaller the units laid off on the base line, the

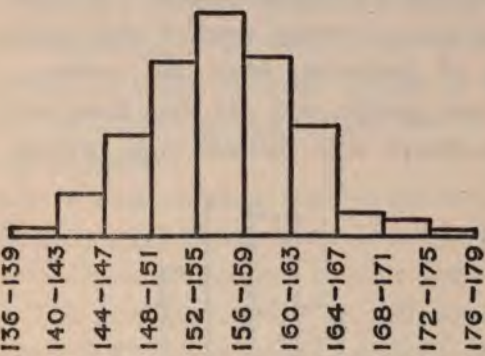

FIG. 28. Distribution curve for Table II.

less broken the curve becomes, so that it is reasonable to suppose that with a very large number of cases and

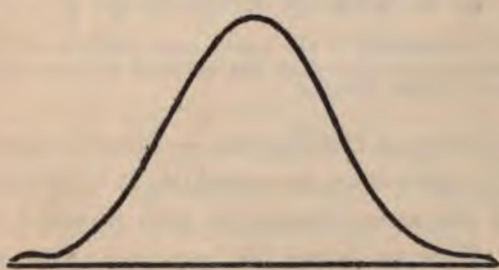

FIG. 29. Form of curve to which Fig. 28 would approximately conform if an indefinitely large number of cases were taken, and the units of height were very small.

small units it would approximate the form of the curve in Fig. 29.

From an inspection of such a curve, it appears (1)

that the majority of persons possess the trait to an average degree; (2) that there are about any equal number of persons above the average and below the average at each corresponding point; (3) that the number of persons becomes smaller and smaller as the amount of deviation from the averages becomes greater and greater, and (4) that there are no really separate groups with distinct gaps between them.

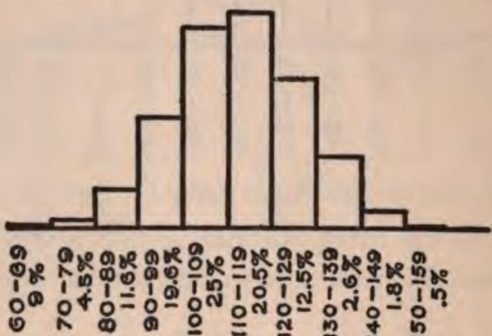

Fig. 30. Distribution of the intelligence quotients of 112 kindergarten children as measured by the Stanford revision of the Binet-Simon scale. (After Terman.)

Distribution of intelligence. — Mental capacities, as far as they have been measured, seem to be distributed in much the same manner as such physical traits as height. Terman found, for example, that when he measured the intelligence of 112 kindergarten children by means of the Stanford revision of the Binet scale, the distribution was shown in Fig. 30. It will be seen (1) that the kindergarten children measured vary in intelligence all the way from 60 to 150 on a scale

where 100 represents average or normal intelligence; (2) that the number of children ranking from 130 to 150 or above is practically the same as the number ranking below 80; (3) that those who are of average intelligence constitute 20 per cent of the number, and that if we add to these the total number in the next higher and next lower groups 65 per cent of all the children are included.

Evidently, if such children were to be divided into groups of nearly equal ability it would not be sufficient to make two divisions—the one inferior and the other superior. The smallest number of such groups that would answer the purpose would be three—one large group containing the persons who are of average or nearly average ability, and two smaller groups, the one of inferior and the other of superior ability.

Intelligence tests and their results. — The bureau of educational research of the University of Illinois has measured the intelligence of large numbers of children by means of the Illinois intelligence scale (see Appendix). This is a series of tests on which each pupil who takes the examination makes a certain score. If the score made is the same as the average score for pupils of the same age, he is said to be of average intelligence and his mental and chronological age are the same. If, however, a pupil whose chronological age is 6 makes a score equal to the average score of 8-year-old children, he is said to be of greater than average intelligence and to have a mental age of 8.

Similarly, another child may be 6 years old chronologically, but his mental age may be found to be but 4 years. Dividing the mental age by the chronological gives the Intelligence Quotient (I. Q.), which is the index of the child's brightness or dullness. The Intelligence Quotient is generally expressed without the decimal point. Thus if a child of 6 has a mental age of 6 his I. Q. is 100; if his mental age is 4 his I. Q. is

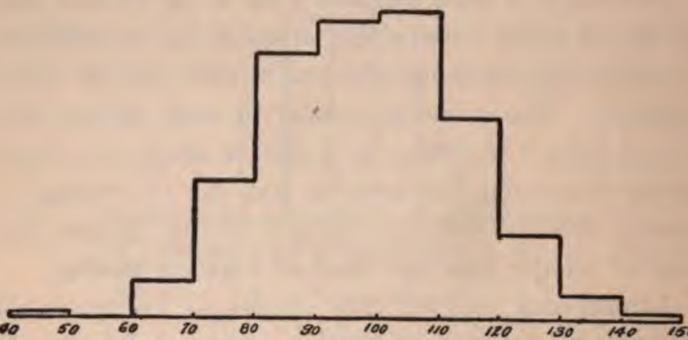

FIG. 31. Distribution curve of the intelligence quotients of 586 eighth-grade children of Decatur, Illinois, as measured by the Illinois intelligence examination. (See Appendix.)

66.6; and if his mental age is 8 his I. Q. is 133. Fig. 31 shows the distribution of the I. Q.'s of all the eighth-grade children of Decatur, Illinois, who were attending school when the examination was given. It will be seen that the curve is of the same general shape as those of Fig. 28 and Fig. 30.

Overlapping of mental ages in the grades. — So great are the differences in the ability of children that the mental ages of children in the various grades over-

lap to a surprising degree. Table III gives the figures for the third, fifth, and eighth grades of an Illinois city.

TABLE III

Mental Age	5.5–6.5	6.5–7.5	7.5–8.5	8.5–9.5	9.5–10.5
Grade III........	15	41	48	34	
Grade V..........	3	11	26	61	63
Grade VIII.......				2	6

Mental Age	10.5–11.5	11.5–12.5	12.5–13.5	13.5–14.5	14.5–15.5
Grade III........	1				
Grade V..........	36	12	9	3	
Grade VIII.......	16	30	35	33	33

Mental Age	15.5–16.5	16.5–17.5	17.5–18.5	Over 18.5
Grade III........				
Grade V..........				
Grade VIII.......	17	12	6	8

These figures show that there are some pupils of Grade III whose mental ability is equal to that of some of the pupils of Grade VIII. The overlapping of the abilities of the pupils of Grade V with those of the other grades is, of course, even more marked. Fig. 32 shows similar overlapping for Grades IV, VI and VIII.

People differ widely in all mental capacities. — Wherever it is possible to measure the mental capacities of a fairly large number of individuals, it is found that wide differences in ability exist, regardless of the capacities tested and the grouping of individuals.

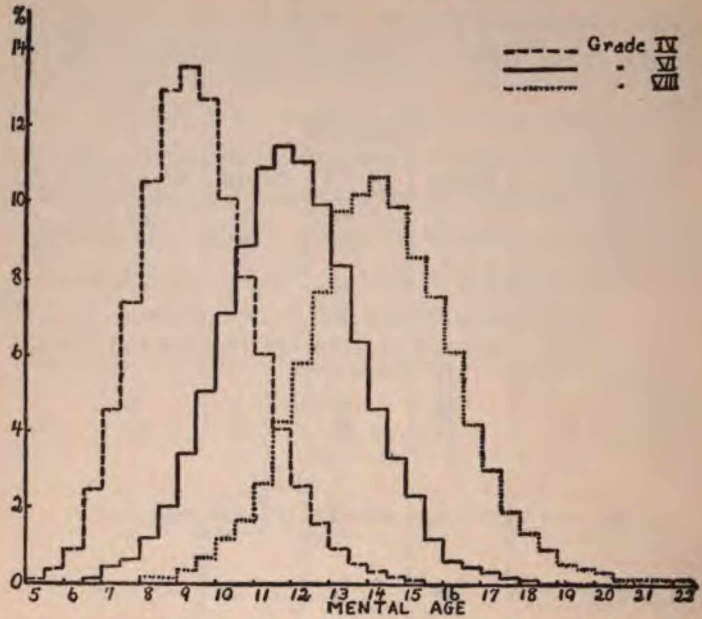

FIG. 32. Showing overlapping of intelligence of Illinois school children in Grades IV, VI and VIII. These curves are drawn from records of the Bureau of Educational Research, University of Illinois, and represent measurements of approximately 20,000 pupils.

The following figures are taken from Starch and show the results of a number of tests on 50 university students:

	Memorizing	*Opposites*	*Addition*	*Subtraction*
Quickest........	60 seconds	30 seconds	31 seconds	15 seconds
Slowest.........	240 seconds	110 seconds	115 seconds	90 seconds

The first column shows the time taken by the two students who were quickest and slowest in memorizing

a stanza of poetry. It will be seen that the quickest student memorizes four times as rapidly as the slowest. The others range between these two extremes, with the larger number at or near the average.

There is almost as great a difference in the results of the "opposites" test, in which the students were shown a list of words and the time was measured that was required to associate these with other words opposite to them in meaning. The same is true for the "addition" test, and in the case of the "subtraction" test the difference is still more marked.

Great differences in achievement between children of same age and grade. — Educational tests given to school children in reading, writing, arithmetic, and other school subjects have given the same picture. Even in a single grade, where children have been selected because they are supposed to be somewhat uniform in their attainments, very wide variations have been shown to exist. H. A. Brown made a study of the reading capacity of children in New Hampshire schools by means of carefully devised tests. He describes the condition found in one fourth grade as follows: "There are six pupils in the class who are totally unable to read. The best reader in the grade is nearly thirty-eight times as efficient as the poorest. The twenty best readers have about nine and one half times as great reading ability as the twenty who have the least reading power."

Table IV gives the scores of a large number of pupils of the seventh and eighth grades in Harlan's standardized test in American history. This test is composed

TABLE IV

Score	Grade	
	VII	VIII
0	3	2
6	19	10
11	37	13
16	63	35
21	79	42
26	94	61
31	93	79
36	100	90
41	115	98
46	113	79
51	99	95
56	65	100
61	65	92
66	54	112
71	35	136
76	35	136
81	18	187
86	13	140
91	3	118
96	6	66
Total	1,109	1,691
Median[1]	43.9	68.2

[1] The median is a measure sometimes used instead of an average. When all the measurements are arranged in order of size, the middle measurement is the median.

of a series of forty-two questions in American history. The correct answer to each question is assigned a definite value and definite instructions as to how to score are given. The table gives the scores made by pupils in May. On the basis of more than 2,000 answers to

each question, the median scores in June are 56 for the seventh grade and 86 for the eighth. It will be seen from the table how enormously children in the same grade differ from one another in their knowledge of American history.

Much the same picture is afforded by the figures in Table V, which shows the scores of more than 2,000

TABLE V

Score	Grade	
	VII	VIII
0	8	23
1	18	51
3	30	87
5	52	121
7	103	154
9	134	133
11	193	201
13	225	203
15	225	237
17	259	217
19	322	214
21	304	233
23	242	214
25	202	171
27	262	63
29	127	94
31		56
Total	2,706	2,472
Median	19.7	17.2

eighth-grade pupils on the Monroe standardized reasoning tests in arithmetic. (See Appendix.) These scores are based on the number of examples in arithmetic in which the correct principle was followed, regardless of the correctness or incorrectness of the

calculations. It is apparent that pupils differing so widely in ability to solve these problems cannot be taught successfully by the same methods and in the same classes. Such instruction almost inevitably comes to be adapted for those of average ability. Pupils whose capacities are either above or below the average cannot profit as they should from such instruction.

Schools must be organized so as to take these differences into consideration. — Such investigations as these indicate that the usual methods of promotion do not accomplish the purposes for which they are intended, namely, the bringing together of pupils who are of the same or nearly the same capacities. Promotions have been on the basis of age or length of time in school rather than on ability to do a certain grade of work, resulting in a handicap to the schools and injustice to individual pupils. Brighter pupils are kept from progressing at their normal rate, and duller pupils are advanced beyond the point where they are able to cope with the work.

Reasons for individual differences. — Individual differences in mental capacities may be due either to native endowment or to training, or to the influence of both combined. It is difficult to prove definitely which of these two factors is the more important, but there is evidence that in many instances the differences are innate. One of the most striking indications that this is the correct view comes from studies of the

effects of equal amounts of practice on individuals who start with differing degrees of ability in some performance. Henmon, for example, studied the results of practice in the four fundamental operations of arithmetic during the course of a school year. He found that "those with the highest initial scores have the highest final scores and gain most both absolutely and relatively."

Figures for the fifth grade are reproduced in Table VI:

TABLE VI

	Average at beginning of year	*Average at end of year*	*Gross gain*
Group I (highest in initial ability)....	15.8	61.5	45.7
Group II (medium initial ability)....	13.3	44.5	31.2
Group III (lowest initial ability)....	11.5	32.5	21.0

Correlation of abilities. — Not only do these differences increase with training, but it seems to be true in general, though contrary to the usual belief, that those who have superior ability along one line are likely to be superior in all others. Thorndike has summed up the evidence on this point as follows: "All trustworthy studies so far made of the relations between amounts of desirable single traits in the same individual agree in finding direct or 'positive' relations between such traits. Having a large measure of one good quality increases the probability that one will have more than the average of any other good quality. He who can learn better than the average through the

eyes tends to learn better than the average through the ears also; he who can attend to one thing better than all other men will be able to attend to many things at once or in rapid succession better than most of them. Artistic ability, as in music, painting, or literary creation, goes with scientific ability and matter-of-fact wisdom. The best abstract thinker will be above the average in concrete thought also. The rapid workers are the more accurate. Intellectual ability and moral worth hang together."

Some of the best examples of studies which have shown that desirable abilities generally go together are those based on school grades. Starch found the correlations between grades in various school subjects given in Table VII:

TABLE VII

Arithmetic and language	.85
" " geography	.83
" " history	.73
" " reading	.67
" " spelling	.55
Language and geography	.85
" " history	.77
" " reading	.83
" " spelling	.71
Geography and history	.81
" " reading	.80
" " spelling	.52
History and reading	.67
" " spelling	.52
Reading and spelling	.58

The degree of relationship in Table VII is expressed by the fractions varying from .37 to .85. A perfect relationship, such that the highest pupil in one subject is

highest in another, the second highest in the one the second highest in the other, and so on, would be expressed by 1. The relationships expressed in the table, therefore, are not perfect, and in cases of some individuals there may be a decided lack of relationship. The figures indicate that such, however, are not the typical cases. It is the observation of such extreme and unusual cases that gives rise to the erroneous opinion that mental capacities are highly specialized.

Necessity for individual instruction. — The net result of the investigation of quantitative individual differences in mental capacities is to show the necessity for flexible schemes of promotion, and the arrangement of pupils into groups that are truly homogeneous with respect to their capacities. Having arranged the pupils in groups that have nearly equal abilities, however, the important qualitative differences still remain. Tests of performance in any school subject fail to reveal why one individual differs from another. In many instances, as we have seen, the reason is a difference in native ability. In many other instances the reason is that the pupils go about their tasks in different ways. They employ different methods. The tests, therefore, do not in reality measure the same mental capacities. Indeed, the teacher is in duty bound to assume that in all cases of slowness of progress the difficulty can be remedied, until all available means of discovering its source and all possible means of overcoming it have been used.

Illustration of the effects of extreme individual differences. — An example of the importance of employing methods suited to the individual child may be cited from Bronner:

We know, for instance, of a boy now fourteen years old whose entire school career has undoubtedly been greatly modified for the better because his intelligent parents understood better than his teachers the harm that was resulting from the use of methods not adapted to his defective functioning in certain mental processes. It was early recognized that the boy had poor auditory powers and exceptionally good visual powers. When five years old he drew a very good representation of the façade of an ancient university building he had seen, and at seven made a most complicated drawing of a quadruple-expansion waterworks engine. Though a great effort was made from the time he was a year or so old to teach him Mother-Goose rhymes and other couplets, he never cited correctly the simplest verse until he was six years old; nor has he ever been able to carry a tune correctly or sing a song, in spite of intensive and oft repeated attempts to teach him simple music. It is interesting to note, for instance, that "America" has been sung and played to him hundreds of times, and even been played by him, without his acquiring the ability to sing it.

At five years of age this boy was sent to a fine private school, where the teaching in the first grades was largely oral. When in the third grade he was placed in a subclass for backward children because he was so retarded in number work. Though the boy made no progress in music nor in memorizing verses,

this was not interpreted as of any significance, nor was any effort made to utilize his good visual powers in place of his defective powers of audition. When, however, his parents were told (by an unusually competent teacher) that the boy was not learning arithmetic and was probably defective in this type of work, they themselves began to teach him by visual presentations. In two weeks he had not only mastered the work assigned in the grade, but led his class. In the next two years, acquiring the power to learn by visualization, he accomplished the ordinary work of four school grades. Now, at fourteen, through extensive compensations, little difficulty arises; he transposes, probably often unconsciously, many auditory percepts into visual form. His own introspections, as well as his method of studying, show very conclusively that visual means are employed whenever possible. His powers of perceiving logical relationships are extremely good, and these, together with his quite unusual visual gifts, enable him to maintain class standing considerably in advance of his years. It is interesting that even now his greatest disability is in regard to language; in spite of all the advantages derived from the best of environmental conditions, the boy shows poor feeling in the use of English. In dealing with foreign languages there is great aptness displayed in learning the structural form, but quite a little trouble with achieving an idiomatic translation. It is evident that in this field he is hardly at all aided by sound.

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CHAPTER XV

MENTAL DEVELOPMENT

Bodily development. — Careful study of the physiological changes that take place from year to year as the child grows older shows that these changes are not always uniform, but that there are periods of relatively rapid and relatively slow growth. The periods of rapid growth are somewhat different in boys and girls. Increase in height, for example, in the case of boys is rapid from the age of four and a half years to eight and a half years, slow from eight and a half to twelve and a half, and rapid from twelve and a half to sixteen and a half. For girls, on the other hand, increase in height is practically constant from six and a half to sixteen and a half. Increase in weight in boys is rapid from six and a half to eight and a half, slow from eight and a half to twelve and a half, and rapid again from twelve and a half to sixteen and a half. For girls increase in weight is rapid from six and a half to eight and a half, slow from eight and a half to ten and a half, and rapid from ten and a half to fourteen and a half. While boys are in general taller and heavier than girls of the same age, girls excel boys in height during the ages between twelve and fourteen,

and in weight between thirteen and sixteen. This means that girls mature earlier than boys; but as soon as the boys reach the stage of maturity they again excel the girls in both height and weight.

Danger of applying average results to individuals. — The figures for increase in height and weight show how difficult it is to give a general statement of the way in which physical development takes place, for the curves of growth in height and weight differ considerably from one another, and the curve for the boys differs from that for the girls. Studies of the other bodily functions and organs, such as lung capacity and size of head, show that these also have their own characteristic curves of growth, differing from those of height and weight. Furthermore, besides the important sex differences that have been pointed out, there are highly important differences between one individual and another of the same sex, which tend to be obscured when the descriptive statement is based on averages. As a matter of fact, the average difference in height and weight between one child and another of the same age is greater than the average increase of the group for a year. As Terman has put it, "Each individual is a law unto himself. A school child may be several inches shorter and many pounds lighter than the average for children of his age, race, and sex, while fully reaching the standard which nature has set for him."

Are bodily and mental development parallel? — The

mental life in its various phases also shows fluctuations of rate of development. The question naturally presents itself whether mental development and bodily development are closely parallel or whether they take independent courses. This question is difficult to answer for several reasons, one of which has already been stated. It is difficult to get a general statement of bodily development, to say nothing of mental development, for changes in one capacity do not closely parallel those of another. In the second place, the investigators who have studied this question are not wholly in agreement in their conclusions. If we confine our attention, however, to the relatively sudden changes of puberty, it has been fairly well demonstrated, as Baldwin says, "that the stages of physical and mental maturity are parallel, irrespective of precocity or brightness. This would require that tall, healthy children of accelerated physiological development be encouraged to proceed through school as rapidly as possible within the limits of thoroughness, and that the small, light children of retarded physiological development be kept below or in the normal grade, doing supplementary work, since these short, light pupils are immature in mental development, although in many cases precocious in degree of brightness. It also follows that rapid, healthy growth favors good mental development, and, therefore, that the healthy growing child should have plenty of physical and mental exercise."

The culture-epoch theory of mental development. — A number of attempts have been made to define in more or less detail the stages of development of mental capacities. One of the first of these was the culture-epoch theory. This theory, in turn, was based on the biological law of recapitulation, according to which life changes in an individual run closely parallel to the changes that have taken place in racial history during the course of the evolution of higher from lower forms of animal life. The culture-epoch theory carries this view over to the mental life, and holds that the stages of mental development in the child correspond to the stages through which the race has passed in its evolution from lower forms of animal life to man in his most primitive form and the subsequent progress from savagery to civilization. According to this view, the child at one stage is a hunter, at a later a nomad, then an agriculturist, etc., in his interests and instincts, and his education should follow these interests and in that order.

Impossibility of describing mental development on basis of this theory. — Whatever may be said of the truth of the culture-epoch theory in its broader aspects, the most careful study will fail to reveal any exact parallelism between the child and the race in mental development. The culture epoch theory has failed to give any detailed view of stages of development in the child, though it has undoubtedly been one of the factors in making educators emphasize the importance

of child study, and of basing educational procedure on child nature rather than on abstract schemes of what may be regarded from the adult point of view as logically appropriate methods.

Another form in which the recapitulation theory has been carried over in the description of mental development is given in the writings of G. Stanley Hall and others. This view has been presented in summary form by Bagley, who distinguishes three stages of development. These stages are (1) the transition period (6-8 years of age); (2) the formative period (8-12 years of age); (3) the adolescent period (12-18 years of age).

The transition period. — This earliest period in the life of the school child is thus named because during this period there takes place "a passing over of interest from means to end, from process to product—an initial development from passive to active attention." Nevertheless, there is but little development of capacity for active attention during this period. The child is not able to reason in any real sense at this time. Hence instruction of an intellectual kind must be largely through appeals to the senses and that which is inherently interesting. In the moral sphere the child's action must be forced in the right direction by reward and punishment.

The formative period. — This is the period for drill and habit formation. "While passive attention is still dominant, the concentration and effort that active at-

tention involves can be demanded with less fear of disastrous consequences. In the early part of the formative period the capacity for logical reasoning is still nascent, although it would seem to make its presence felt in a slight degree at about the age of nine."

The adolescent stage. — The adolescent stage is characterized by mental changes as profound as the physical changes of that period. These changes are first of all of an emotional character. "Fear, love, pity, jealousy, emulation, ambition, and sympathy are either now born or springing into their most intense life." The child now acts from social motives rather than individualistic as heretofore. He may now be influenced both intellectually and morally by appeals to reasoning.

Evidence lacking for marked changes from period to period. — While the picture that Bagley has given is suggestive and instructive, it must be accepted with reserve because (1) it is not based on experimental evidence. All such descriptions are necessarily limited to the impressions gained by observation of children, and there has been much disagreement even among the most capable observers; (2) it tends to exaggerate the suddenness with which mental changes actually occur. It is certainly not true, for example, that the child can reason in any essentially different way after the age of nine from that in which he reasons before that age. The truth is that the child's reasoning capacity is present from the earliest years, and that he is

able to deduce conclusions whenever the data are simple enough for him to understand. This capacity in the young child is limited by his lack of experience. Just as untrue is it to say that there is ever a time after school age when the child is not capable of some degree of sustained effort and attention. Furthermore, while the physical and mental changes of adolescence are profound, there is little, if any, ground for holding that at this time the child becomes a new being, or that he becomes suddenly endowed with entirely new capacities.

Kirkpatrick's stages of mental development. — Another elaborate scheme of representing stages of mental development has been contributed by Kirkpatrick, who uses susceptibility to social influences as the criterion. On this basis the following stages may be distinguished: (1) Pre-social. During this period the child is influenced only by objects and by animals and persons in the same way as if they were objects. This period ends near the close of the first year. (2) Imitative and socializing stage. During this period, which lasts till about three years of age, "the child becomes more and more susceptible to mental influences and his mental states are determined to a considerable extent by the mental states of those around him."

(3) The third stage, which culminates at about six years of age, may be designated as the *individualizing stage,* during which the conscious personality that has

been developed during the previous period becomes more distinctly individual and asserts itself, instead of merely assimilating the characteristics of others.

(4) The fourth stage, ending at about twelve years of age, may be described as the *period of competitive socialization.* It is a period when a child is introduced to a wider social environment and in which the impulses to excel in competition are prominent and are brought out in association with others of the same age.

(5) The fifth stage, culminating at about eighteen years of age, may be called the *pubertal* or *transitional* period. During this time the youth and maiden become more susceptible to many social influences that formerly affected them not at all, and many new and important interests develop that are characteristic of the sex and age.

(6) The sixth period, ending at twenty-four years of age, may be designated as the stage of *later adolescence,* during which the individual is ushered into the larger world of thought and action and becomes prepared to take his part in the various activities of the race as a fully developed man or woman.

Such schemes must be accepted with caution. — Like the other scheme just presented, this one must be viewed with the same caution, as Kirkpatrick himself is careful to point out. In reality there are no sharp breaks between these various periods; the capacities of one period are not absent from the preceding

and succeeding periods; the ages given must be regarded as only approximate, and even the order of the stages may vary in different individuals.

It is safe to say that at the present stage of our knowledge no description of the child's mental life in terms of stages of development can adequately represent the facts. Some children develop rapidly at certain periods with respect to a particular capacity, others slowly, and still others gradually. Even when changes occur relatively suddenly, there are frequently great differences in the ages at which these changes appear. Take, for example, the case of instincts. Here, if anywhere, we should expect to find uniformity of development in different individuals. It is true that some instinctive tendencies crop out more or less suddenly, but to argue a general law of development from these cases is impossible. It is a matter of common observation, for example, that some children pass through stages in which fear of certain situations seems to develop suddenly, and after a certain length of time as suddenly disappears. Other children of the same family may not exhibit the same tendencies to sudden development of fear of these situations at all, or if at all they may appear at entirely different times. Of course, it may be said that these differences are due to differences in experience, but as a matter of fact they often occur when they cannot be accounted for in this way.

The facts of mental development, therefore, at the present stage of our knowledge cannot be adequately described in general terms. We are justified only in presenting the facts that are known with regard to certain capacities that have been measured, and even then it is necessary to remember that these pictures of mental development must be taken with reserve (1) because the measurements have been made on different groups of children at the various ages instead of the same children from year to year, and (2) because it is certain that the differences between one child and another in respect of any particular capacity is frequently greater than that from one age level to another. Keeping these limitations of our data in mind, we may add to what has already been said in the foregoing chapters the description of some particular mental capacities, which can be outlined in more or less accurate fashion.

Development of motor control in tapping. — Some light is thrown on the development of motor activities by studies that have been made of the rate at which children can tap at various ages. All investigators agree that the rate of tapping increases from the ages of six to eighteen years. There may be periods of rapid and slow growth, but the investigations do not agree in showing what these are. Bryan's study indicates that the muscles of the fingers and wrist are less developed at six years than are those of the elbow and shoulder, as shown by Table VIII, where tapping

TABLE VIII

Boys

	Six years
Fingers	57
Wrist	64
Elbow	72
Shoulder	69

ability at six years of age is expressed as a per cent of the ability at sixteen years of age.

While these figures show a relative immaturity of finger control at the age of six, it is difficult to see how they can be used, as some writers have used them, to support the view that writing should not be taught until the age of nine or ten, or even that the early writing of the child should be by means of the so-called arm-movement method rather than finger movements.

Development of the instinct for making collections. — Practically the only investigation of instinctive activities the results of which can be put in terms of numbers is that of Burk, who got replies from more than one thousand children through their teachers with reference to the number of collections they had made. Classified by age and sex, the records were as in Table IX:

TABLE IX

Age	6	7	8	9	10	11	12	13	14	15	16	17
Average per child	1.5	2.3	4.0	4.0	4.4	3.3	3.0	3.4	3.0	2.9	2.7	2.5

Burk enumerates three stages through which this instinct seems to pass: (1) Up to the age of eight the

child simply heaps up possessions in haphazard fashion. (2) From the eighth to the eleventh or twelfth year the instinct is strongest and applies to the largest number of kinds of things collected. This is the period when the child is most interested in making collections of butterflies, flowers, bird's eggs, etc. (3) The third stage, in the adolescent period, is the one that needs careful direction along scientific lines. Otherwise it is likely to take the form of collecting articles of no value except for their sentimental interest instead of becoming a motive for valuable training.

Development of the play instinct. — Studies of the play of children have been made by the questionnaire method. These show that the interest of both boys and girls in toys is present very strongly at an early age, but declines steadily after the age of six. On the other hand, interest in ball games rises steadily up to adult years in the case of boys, while with girls it is never great and remains virtually constant. Games of chase are engaged in extensively from the age of nine up to fourteen, when the interest in them begins to decline. Rivalry and coöperation, two important phases of play life, are strong from the time of the early period of adolescence and into adult life. (See Fig. 33.)

Development of capacity to make drawings. — Allied to play, especially in its earlier manifestations, is drawing. Children's drawings have been studied in much detail and thousands of their drawings have

been collected and classified. We may take as an illustration of the stages of development enumerated by different authors that of Meumann. The first stage is that of *scribbling,* lasting up to about the fourth year.

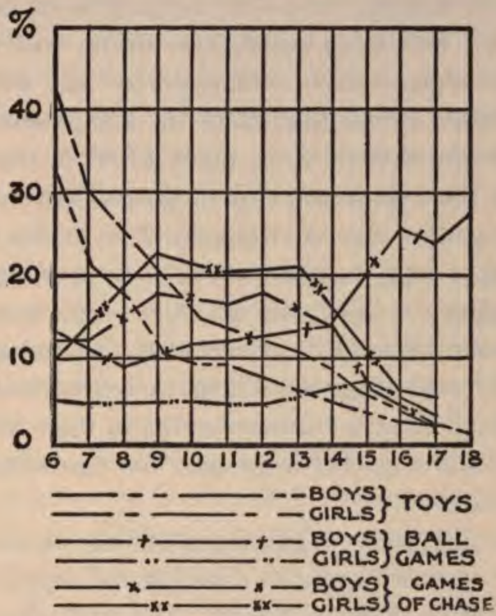

FIG. 33. Curves showing the interest of boys and girls at various ages—in toys, ball games and games of chase. (After Croswell.)

This stage begins with aimless lines and scratchings, enjoyed apparently only because of the activity connected with them, but with no purpose of representation. Later the lines become parts of objects to suit the child's fancy. Only toward the latter part of the period is there any beginning of real representation,

and then it is a bringing together of lines to stand for characteristic parts of the objects represented.

The second stage is that of the *schematic outline.* The child does not attempt to represent the object in the way it is seen, but rather to draw what he knows about it. The same schematic outline will serve to represent men, women, and children, and will suffice for animals. This stage lasts till about seven years of age in the case of those more gifted in drawing.

In the third stage the child begins to have a *feeling for lines and forms.* At this period he makes the first attempts to reproduce objects in their true form with parts properly related, though mixed with such drawings are the schematic outlines of the second stage.

In the fourth stage the schematic representation disappears and objects are represented in their *true form,* though little capacity is present for representing the third dimension.

In the fifth stage, beginning about the eleventh year in those more advanced in drawing, the representation of *perspective* begins to appear. The sixth stage is that in which proper distribution of *light and shadow* effects are added.

Meumann states that in general boys are superior to girls in drawing ability, though girls have a certain degree of superiority in sense of color and decorative work.

Development of attention. — It is difficult to test attention, because it is so obviously a function of every

other capacity. Bagley's statement that there is a development of active attention as the child grows older is confirmed by ordinary observation. Everything seems to indicate, however, that this development is gradual and that, furthermore, children very early are capable of voluntary attention. There are clearly wide variations in this respect. The assumption that children are capable of sustained attention not at all, or only in connection with play and other purely instinctive activities, certainly does not hold for the majority of children at school age. Interest in the school subjects, for example, may in the majority of cases be as easily aroused as in the case of adults. Most children are much interested in the accomplishment of forms of activity that they see older persons performing. Like older persons, too, they can and do whip up their flagging attention to such tasks under the spur of social pressure. It is true that younger children tire more easily than older under such conditions, and need more frequent changes and shorter periods of employment on any one test; but the mental picture of the child at school age here, as elsewhere, is not essentially different from that of older children.

Development of memory. — Contrary to the generally accepted belief, children do not memorize more readily than adults, even in the case of rote learning or memorizing word for word. While adults sometimes do not learn by rote as readily as children, it is due to lack of practice in that method of learning.

With practice the adult is superior to the child in this as in other mental capacities.

Immediate memory, that is, ability to reproduce material immediately after learning or seeing it, can be tested by presenting letters or digits or words for a short time and then requiring that they should be reproduced. The largest number reproduced in the correct order is called the "memory span" for that kind of material. Smedley found that the memory span for digits when heard was better than when seen in the case of younger children from seven to nine years of age; but from that time onward the visual method of presentation is increasingly more effective. Increase in capacity for both the visual and auditory increases rapidly, the visual up to fourteen and a half, the auditory up to thirteen and a half years of age. After these ages the increases are slow.

Development of reasoning capacity. — It is difficult in the case of all mental capacities to state how much of the difference between the child and the adult is due to the child's mere immaturity and how much to lack of experience. Indeed, the capacity itself is conditioned by experience, and has no existence apart from it. It is especially difficult to find tests of the reasoning capacity of children adequate to their experience; but ordinary observation of children shows that they reason in situations the elements of which are familiar to them. Thus a child of four years of age, who was

accused of having made finger-marks on a white door, replied: "I could n't have done it, for I am not tall enough." In some cases the conclusion of the child may be ridiculous to the adult, but it is none the less a reasoned conclusion, as in the case of the two-year-old who asked why the stove did not walk, since it had legs.

Tests of reasoning as shown in the ability to solve arithmetical problems show no marked increase in capacity at any particular school age. On the contrary, there seems to be a gradual increase in ability from one grade to another of the elementary school. The figures of Table X are taken from Bonser's study in which the arithmetical problems of the army intelligence scale were used for testing 632 pupils from Grade 4B to 8A:

TABLE X

Grade	4B	4A	5B	5A	6B	6A	7B	7A	8B	8A
Average	3.8	5.02	5.5	5.8	6.3	7.2	7.5	7.7	8.8	9.3
Number of cases	37	76	44	56	64	67	69	82	58	79

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CHAPTER XVI

READING

In the next four chapters it will be the purpose to apply the principles already studied to some of the more common branches of elementary school learning, and to study the processes involved in them in some detail. In all of this work it will be convenient to follow the divisions suggested by the principle of the sensori-motor arc. We shall then have to study the various sensory, motor, and central processes involved in these different forms of learning. In making this classification, however, it should constantly be remembered that these processes are not in reality separate processes, but only distinguishable aspects of a single unitary group of processes.

Sensory processes in reading. — Beginning, then, with the sensory processes involved in reading, it will be noted at once that these processes are the ones we have already learned to recognize as perceptions. Psychologically, a printed word is as much an object of visual perception as that occurring on looking at a tree or a stone. Valuable light has been thrown on the process of perception involved in reading by the experiments with the tachistoscope. The tachistoscope

is a piece of apparatus by means of which visual objects, such as words and letters, can be exposed to view for very short periods of time and then covered by means of a screen. The instrument may be adjusted so as to present the material to view for any short interval desired. If this time interval be made so short that the eye does not move during the period of exposure, one may study the process of recognition of words and letters during the time of a single visual fixation. If separate letters not forming words or syllables are exposed in this way, six or seven at most are recognized. On the other hand, long words of twenty or more letters may be recognized, especially if they are familiar, as well as simple sentences containing from four to six words. In these experiments words may be misspelled without the observer noticing anything unusual. Foreign words are less easily perceived and in general more familiar words are more easily recognized than others of the same length.

It is frequently a matter of surprise to older persons who have been taught to read by the alphabetic method that children may be taught to read without having first learned to recognize the letters of the alphabet. Such experiments as these show why this can be done. Visual recognition of words does not imply the recognition of the separate letters of the word, any more than the perception of objects in general implies the perception of all the parts of the object. The general form of the word as a whole, to which certain of the more

conspicuous letters may largely contribute, is all that is necessary in order that the word may be perceived. Reading in this way is more rapid and effective than would be the case if it were necessary that each separate letter should become, in turn, an object of attention.

Motor processes in reading. — These principles and others are further emphasized by a study of reading on its motor side. The most obvious motor processes connected with reading are those that bring about the pronunciation of the words after they have been perceived. The child has usually already fixed forms of speech for nearly all the words used in his early reading. Teaching the child to speak these words is not usually a problem for the teacher, though much needs to be done to improve his pronunciation and enunciation in detail. The child has learned to pronounce these words by imitating others, and neither speaks nor hears them as a series of separate sounds, such as phonetic analysis reveals them to be. They are heard as unitary wholes, just as they are seen as unitary wholes when printed. Indeed, unless special instruction in phonetic analysis is given, the word as heard and pronounced is broken up into its elementary sounds to a much slighter degree than is the case when the word is perceived visually.

Distinction between silent and oral reading. — At this point a distinction must be drawn between oral and silent reading. The earliest instruction of the child

must almost of necessity be in the oral form of reading, but this kind of reading does not constitute the goal of the learning process except in a minor degree. The eventual usefulness of the child's learning to read must depend almost exclusively upon the ability he acquires to read silently with speed and understanding. In silent reading the motor processes of the throat which in oral reading produce the spoken words are modified and repressed, though it is probable that they are seldom if ever entirely absent. Children find it difficult to read to themselves at first without at least whispering. Many persons never get beyond the stage of lip-reading, and most persons have more or less marked muscular changes in the throat as silent reading progresses.

Such considerations as these show that oral and silent reading are in part different activities, and suggest that it is not safe to assume that training in oral reading will result in efficient silent reading. In oral reading the speed is limited by the time it takes to pronounce the word; in silent reading the speed may be similarly limited by the motor speech processes that accompany it. Only by training and practice can these processes be modified so as to approximate in speed the rapid movement that it is possible for the eyes to make in silent reading.

Eye movements in reading. — The last statement turns our attention to another group of important motor processes common to oral and silent reading—

that is, eye movements. It is probable that if we knew all there is to know about the way in which the eyes move in reading we should be forced to conclude that it is as important to train these movements in learning to read as to train the hand in learning to write. Various means, among them that of photographing the eyes on a moving plate or by a kinetoscopic camera, have been used to increase our knowledge of what the eye does in reading. It is found that the eye never moves in a continuous left-to-right movement, as would be naturally supposed, but that it fixates some point in the line of print, then rapidly moves forward to another point of fixation, and thus by a series of stops and movements passes along the line. It is only at the time that the fixation pause is made that the words of the printed page are perceived. While the eye is moving nothing is seen, the movement being too rapid for clear vision.

Fig. 34 shows the characteristic movements of the eye in the reading of a practised adult reader. It will be seen that there are three distinguishable kinds of movement. Usually the point of the first fixation is well beyond the beginning of the line; the eye then moves on from point to point in the left-to-right direction, usually stopping and making the last fixation before the end of the line is reached. Occasionally, however, the eye makes movements backward in the right-to-left direction. These movements are usually very short, and undoubtedly indicate that at these

points there is a need for clearer vision of what has already been read. Finally, there is the long sweep of the eye from near the end of one line to near the beginning of the next. The number of fixation

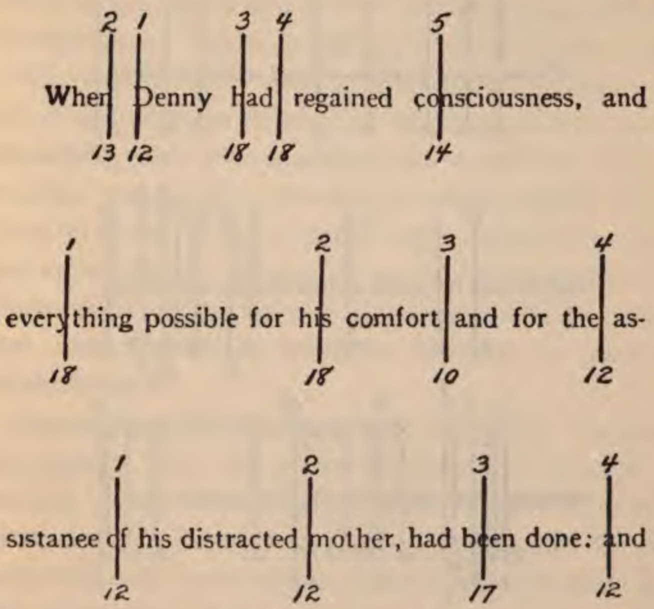

FIG. 34. Showing eye-fixations of an adult reader in three lines of print. Each vertical line indicates a fixation. The order in which the fixations were made is indicated by the numbers above each line. The numbers below the line indicate the duration of the fixations in units of fiftieths of seconds. (From Judd, Reading: Its Nature and Development, by permission of the author.)

pauses varies with the length of the line, the difficulty of the content, and with the practice of the reader.

Eye movements of trained and untrained readers. — A comparison of the eye movements of practised and

unpractised readers (both children and adults) shows that the latter make more pauses in the course of the reading, and this accounts for their slowness. Further-

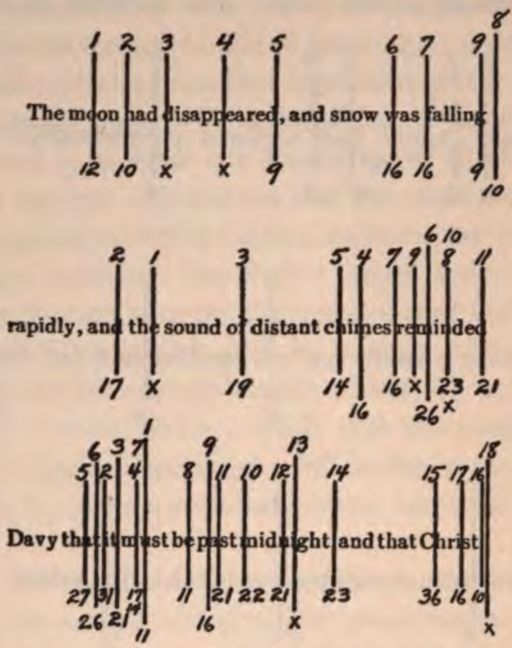

FIG. 35. Showing eye-fixations during silent reading of a slow reader in the fourth grade who has been shown by tests to have poor ability to comprehend what he reads. Note the large number of fixations and of shifting movements. (From Judd, Reading: Its Nature and Development, by permission of the author.)

more, the pauses of unpractised readers are longer, and more of the backward shifting movements occur. (See Fig. 35.) Clearly, then, we have here in the eye movements used in reading an example of a habit that requires training just as much as is the case of the train-

ing of the hand to write. The observations of the investigators of eye movements in reading indicate that no small part of the facility of good readers depends not only upon the reduction of the number of necessary pauses in the course of the reading, but also the moving of the eyes along in a series of rhythmically related movements. The method of eye photography has been used by Judd and others to diagnose the difficulties that poor readers have to contend with in reading, and in the attempt to remedy their faults. Even in those extreme cases where inability to read has approximated alexia, or word-blindness, analysis of the child's methods and careful individual instruction have in many instances resulted in marked improvement.

Central processes in reading. — Having discussed the sensory and the motor processes in the act of reading, we now turn to the central processes involved. First of all, in learning to read, it is necessary for the child not only to recognize the words to be read, but also to associate them with the sounds of the words as pronounced. This act of association follows the laws already laid down for association. When the word is pointed to on the blackboard and the teacher pronounces it, the child forms an association between the sound of the word (auditory impression) and its appearance (visual impression), which is the more permanent the more attentive the child is to these impressions (factor of vividness). Repetition serves

to increase this permanency of association, while lapse of time (lack of recency) tends to break down the association. Usually the associative processes set up by the pronunciation of the word are reinforced by the child's own articulatory processes. Thus the association will involve not only the auditory impressions from the child's voice but the kinesthetic sensations from those muscles of his throat concerned in the speaking of the word.

Central processes involved in understanding what is read. — Thus far we have been engaged in describing the act of reading as a relatively mechanical process. All of these processes may in some cases go on uninterruptedly without true reading taking place at all, as when a selection is read correctly, even as to emphasis and inflection, without, however, the meaning being grasped. The heart of the act of reading is the acquisition of meanings from the printed page. All the mechanisms included in the reading act thus far described exist for this purpose alone and have no significance apart from this purpose. The nature of meaning as a psychological process has already been discussed in the chapter dealing with language. In the present connection it is necessary to add, however, that difficulty arising in connection with reading for thought-getting is usually not connected with the meanings of individual words, though such difficulty may sometimes be present. The much more usual difficulty is that of combining the meanings of words,

phrases, and sentences. This involves memory of what has already been read in addition to a certain amount of anticipation of what is coming, together with those higher thought processes necessary for the understanding of such logical connections between ideas as may be expressed in the reading material.

It is in these memory and anticipatory and higher thought processes that consciousness must be chiefly engaged if the purpose of the act of reading is to be accomplished. This will not be the case unless the other processes have become so automatic as to free the attention for the acquisition of meanings in connected sequence. Undoubtedly this explains why it is that in general rapid readers get more thought from the reading than slow readers, as has been shown to be the case by a large number of careful investigations. The slow reader has not mastered the mechanics of the reading act, as is shown not only by the fact that he is slow, but also by the fact that he understands less of what he reads.

Individual differences in reading capacity. — The great complexity of the act of reading must have prepared us to expect that great individual differences in reading efficiency exist among pupils of the same age or grade. In the Cleveland Survey the tests of oral reading showed that "in many third-grade classes there were pupils reciting together who ranged in ability from those unable to read as well as the average first-grade pupil to those able to surpass the average eighth-

grade pupil. In the intermediate and upper grades there were a number of pupils who were still unable to pronounce at sight some of the simpler words, and stood at a level no higher than that of the average first- and second-grade pupil. In the grades above the second there were pupils in nearly every class who were excellent oral readers and for whom it is doubtful whether continued daily drill is longer necessary."

That the condition with respect to silent reading is usually even more unsatisfactory may be seen from Tables XI and XII. These tables give the scores in the Monroe silent reading test (see Appendix) of three classes (grades 4A, 6B, and 8A) of a single school system of a city in Ohio. They are selected almost at random from a large number of similar records on file in the Bureau of Educational Research of the University of Illinois. In Table XI the rate is given in the

TABLE XI

Rate per minute	*Grade 4A*	*Grade 6B*	*Grade 8A*
140–149	1	3	4
130–139	0	4	1
120–129	2	0	0
110–119	4	6	8
100–109	1	4	7
90– 99	2	11	8
80– 89	4	10	5
70– 79	7	0	0
60– 69	9	11	4
50– 59	10	5	2
40– 49	3	4	
30– 39		0	
20– 29		0	
10– 19		1	

left-hand column and the number of pupils in each grade reading at that rate is given opposite. Thus one pupil in grade 4A reads at a rate of 140–149 words per minute; 3 pupils in grade 6B and 4 in grade 8A read at the same rate, etc.

Table XII gives the results for the same classes in

TABLE XII

Comprehension	*Grade 4A*	*Grade 6B*	*Grade 8A*
42–44			1
39–41			0
36–38			3
33–35		3	4
30–32	1	1	3
27–29	0	6	4
24–26	2	2	4
21–23	3	4	6
18–20	3	9	1
15–17	5	10	8
12–14	6	12	4
9–11	12	6	1
6– 8	8	2	
3– 5	5	2	
0– 2	1	2	

comprehension. This is tested by the ability of the pupil to answer questions based on what was read. Different values are assigned to the correct answers to the questions. The table shows that one pupil in grade 8A made a score of 42–44 in comprehension; 3 in the same class scored 36–38, etc.

Judd also found in the Cleveland Survey that the individual differences of children of the same grade are even more marked than in the case of oral reading.

This fact is well illustrated in Fig. 36, which presents a comparison of the same pupils in oral and silent reading. The upper figure shows the distribution of these pupils on the basis of their rate of oral reading. The lower figure is based on the rate of silent reading. The relatively spread out character of the latter figure indicates that there is a much greater amount of differ-

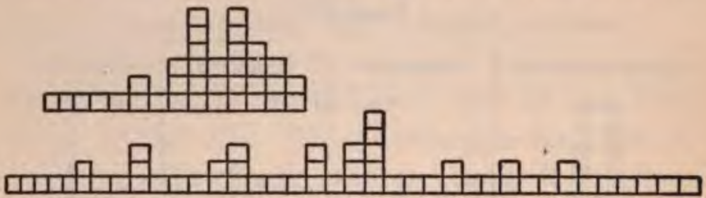

FIG. 36. The upper curve shows the distribution of the pupils of a fifth grade of the public schools of Cleveland, Ohio, in rate of oral reading. The lower shows the distribution of the same pupils in rate of silent reading. (From Judd, Measuring the Work of the Public Schools, by permission of the author.)

ence between pupils in silent reading. Undoubtedly this difference is due in part to differences in actual capacity, but in part to the fact that, silent reading being left to take care of itself, some pupils have learned for themselves while others have not. Systematic training in silent reading for the whole class might be expected to reduce the amount of difference and make the distribution in silent reading more like that in the oral reading.

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CHAPTER XVII

SPELLING

Motor processes in spelling. — It will be convenient to begin the discussion of spelling by considering the motor processes concerned first. Spelling may be either oral or written. In the former case there is nothing to be learned by the child so far as the motor processes are concerned, since he has presumably already learned to pronounce the names of the letters of the alphabet. In written spelling, on the other hand, the motor activities have been only imperfectly learned. Written spelling, therefore, is dependent for its effective use upon handwriting. To the degree to which the handwriting has not become thoroughly mastered the pupil is handicapped by divided attention between the activity of writing and that of spelling. An additional reason for this discrepancy between oral and written spelling consists in the fact that they are in reality two separate kinds of motor response, and, while they are often connected, there is no necessary relation between them. It is clear, however, that if spelling is to be begun early in the child's school career, much reliance must be placed on oral spelling with the hope that such connections may be set up.

Sensory processes in spelling. — On the sensory side spelling is related to reading, since it deals with the same materials. The object of perception in spelling, however, is quite different from the object of perception in reading. While reading is more efficient the larger the unit of perception becomes, in the case of spelling the unit of perception must be the letter. Undoubtedly in the case of practised spellers the writing of words may be in response to large units, such as words and especially syllables; but in the case of the child each letter is written individually, and in any case each letter must be thought of in a sense that does not hold good for the act of reading.

It is for this reason that the best method of teaching reading may not be, and probably is not, the best method of producing good spellers. Indeed, the two processes are naturally opposed, since spelling requires analysis of words into their component elements, while reading is the more effective the longer the unit apprehended within the limits required for getting the thought without mistakes.

Relative value of the various means of sensory impressions. — Granting that the child has learned to associate the names and appearance of the letters of the alphabet and is able to write them, there are a number of ways in which words can be presented in order to impress their spelling upon the learner. Thus they may be presented in the form of auditory or visual impression, and these may or may not be rein-

forced by kinesthetic sensations from throat or hand in speaking or writing the letters. It becomes a matter of considerable importance to know which of these methods of presentation gives the best results in the learning of the spelling of words. Lay's investigation on this point may be cited. Lay used nonsense words and thus was able to compare the results of the different methods. Testing 3,000 children of the third to the eighth grades in German schools, as well as a number of older students taking teacher training courses, he found that the percentage of mistakes made for the various kinds of presentations were as follows:

TABLE XIII

	Percentage of errors
(1) Hearing (pupils not making any speech movements)	3.04
(2) Hearing (pupils repeating silently)	2.69
(3) Hearing (pupils repeating aloud)	2.25
(4) Seeing (pupils not making any speech movements)	1.22
(5) Seeing (pupils repeating silently)	1.02
(6) Seeing (pupils repeating aloud)	0.95
(7) Copying (pupils repeating silently)	0.54

Good spelling dependent on careful observation of the details of words. — It appears, therefore, that the visual method of presentation is superior to oral, and that copying is superior to both. Lay holds that his results show the great importance of the motor factors, since in each case the more pronounced these factors were the better the results. It seems probable, however, that the superiority of these results is due not so much to the presence of the motor factors as such as to the fact that by pronouncing the letters the words

are more completely analyzed into their constituent letters. Copying makes this sort of analysis very thorough-going, since each letter must be written more or less independently. It is to be noted that the words used by Lay were phonetic in their character, yet the visual method of presentation was found to be superior to the auditory. If this result obtains with words that are spelled as they sound, it may be expected that the visual method is even more important in the spelling of English words, so many of which are of a non-phonetic character. Indeed, the habit of visual analysis of words is of fundamental importance if a person is to be a good speller of English words. The good speller is one who has acquired this habit with respect to all new words that he meets.

On the other hand, it cannot be denied that the recognition of the sound elements leads to a ready and facile acquirement of spelling ability in most cases. Those combinations of letters into syllables which are phonetic in character and which occur frequently, like *-ent*, *-ly*, *-tion*, etc., when once learned by correspondence of sound and letter serve to lighten the task that would otherwise be more difficult by the method of visual analysis alone. In other words, dividing words into syllables, when these have definite sound values, makes the unit of perception and memory longer than the single letter and makes it more comparable with the unit that is used in reading.

Individual differences in spelling. — It must be

remembered that the above results are based on averages of many individuals taken in the mass. It does not follow that each individual of the mass will learn spelling most effectively by the methods suggested. Individual differences are so great that there will always be some pupils for whom the methods best adapted for the class in general will be inappropriate. Since spelling depends on the revival of memory images of the word to be spelled, the individual differences in mental imagery will undoubtedly have their influence on the effectiveness of the method used. If the pupil is weak in visual imagery the method of visual presentation may be of little value, while to another habits of phonetic analysis will be relatively unimportant.

Two methods are possible in order to avoid this difficulty. One is by the method of so-called multiple appeal, that is, by the use of all methods of presentation, so that if one is not effective another may be. Such methods are obviously wasteful. The second method is that of diagnosis of the source of difficulty in individual cases and the application of methods in accordance with the diagnosis. It must always be remembered, further, that few cases exist where defects are so serious in the use of any type of mental imagery that they cannot be overcome by special training. Indeed, what needs to be trained in all pupils is not so much the ability to spell individual words as the habit of dealing with all words in a manner that will

lead to their correct spelling. Some pupils readily learn this *general* habit, but relatively few. If more attention were given to instructing pupils how to deal with words for purposes of spelling, much less time need be spent on individual words. This is the reason why there seems to be so little relation between the time spent in drill on spelling and the results accomplished, as shown by a number of investigations, notably those of Rice and Cornman.

Without doubt, special drill is necessary on a certain limited number of words in most common use, but beyond this the acquirement of the ability to analyze words phonetically or visually or both is absolutely necessary if the pupil is to become a good speller. It is, therefore, important not only that mistakes be corrected, but also that the kinds of mistakes that occur in individual cases be studied with a view to overcoming faults of learning and of writing. In other words, instruction in how to study the spelling of words is of as much importance as the learning of individual words through drill and testing.

Most practice in spelling should be by means of writing. — Since the form in which spelling is a useful capacity is in writing, it is reasonable to suppose that any testing should be made in writing, and that oral spelling is a relatively inefficient form of motor reaction in clinching the results of the learning. Furthermore, it is well known to all who have observed school children that ability to spell words in columns is no

safe guaranty of ability to spell them correctly in sentences. One reason for this is that in spelling in sentences the attention of the pupil is much more occupied with the meanings of words than when writing them separately in columns. Again, lapses—those peculiar mistakes in association that cause a person to write one letter when another is intended—are much more likely to occur under conditions of the writing of words in sentences.

Value of rules. — The question of the value of rules in spelling has been much debated. A rule thoroughly understood is, in general, a valuable short-cut to knowledge. It is essentially an idea or group of ideas, and has the advantage in learning that we have already seen attached to such mental processes. In the case of the spelling of English words, however, the number of rules that apply and are simple enough to understand are very few. Most spelling rules have so many exceptions that only those of most general application and those that are the simplest to understand should be learned, and these at the later elementary school period. Their value is chiefly in arousing that critical sense toward one's own spelling which is essential to the habit of good spelling.

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CHAPTER XVIII

WRITING

Writing an illustration of trial-and-error learning. — Learning to write is an illustration of the development of a sensori-motor habit largely dependent on the trial-and-error method, which has already been described. It may, therefore, be expected that writing can be learned only by a large amount of continual practice. The child at the beginning makes many superfluous movements that must eventually be eliminated, and the many muscles that at first do their work more or less separately must be coördinated so as to coöperate with one another. Furthermore, the whole process must become so automatic as to free the attention for the purpose of dealing with the meanings that are to be expressed.

Better to begin with word wholes rather than their elements. — In beginning to write, the child is in reality drawing from a copy. Logically, all written words are composed of letters, and these in turn of lines. It seemed to the early educators, therefore, that the process of learning to write could be simplified for the child by teaching him at first to draw separately the lines of which the letters are composed, and later

combine them into letters and words. A psychological analysis, however, reveals the fact that words are no more split up into their logical elements for purposes of writing than for reading. Just as in the case of reading, writing is the more efficient to the degree to which words are responded to as unitary wholes. Writing does not consist in the joining together of separate lines or even letters, but in the writing of entire words in a single act. Experience shows that the child develops the capacity for expressing himself in larger writing units more rapidly and with no injury to form if he is habituated to respond to entire words from the beginning.

Rôle of visual and muscular sensations. — At first, when it is still necessary to place the copy before the child for his guidance, visual and muscular sensations coöperate to produce the results. Eventually the muscular sensations will become the chief cue to movement, and vision will be chiefly concerned in general oversight of the process—the spacing and alignment of the words as they are being written and criticism of the spelling of words already written.

Relation between form and speed. — The relation between the form and movement in writing is one of the problems that must be taken into consideration in both the beginning and later periods of practice. In general, writing at a speed greater than one's no rate causes deterioration in form. Studies of w abilities show, however, that the more rapid

are, on the average, better writers from the standpoint of form. Since form is relatively unimportant provided legibility is not sacrificed, the aim in the later years of practice in writing would seem to be that of increasing one's normal rate of movement to the highest point consistent with legibility.

In beginning writing, on the other hand, the emphasis should be in the other direction. The aim of the child at first must be to produce as exact a reproduction of the copy before him as possible. He needs to learn how it feels (muscular sensations) to produce the right movements. He also needs to build up correct visual images of letter shapes. If he is allowed to repeat unsatisfactory forms over and over again the practice defeats its own end, since it will ultimately be necessary to break up the bad habits being formed.

Writing involves many groups of muscles. — If all the muscles more or less directly concerned in writing are taken into account, they undoubtedly number several hundred. When it is remembered that all these must be coördinated and that there are no purely instinctive adjustments directly applicable to writing, it will be seen how difficult a task the child faces in learning to write.

Holding the pen. — Let us examine some of the principal movements that must be executed in writing. First of all it is necessary to grasp the pen-holder or pencil in a certain way. This is ordinarily accomplished by the combined action of the thumb and the

first and second fingers. Many children have learned to hold the pencil in approximately the correct fashion before entering school in their early attempts at writing and drawing; but in any event it must be learned, the natural method of holding such objects being by the reflex grasping movements of the whole hand, which is entirely unsuitable for writing.

Forming the letters. — Next, consider the movements that are directly responsible for the forming of the letters. It is entirely possible to form the letters by movements of the arm as a whole, using the shoulder joint as an axis. This is the natural method in producing very large letters, and also where no support for the arm is provided, as when writing on the blackboard. Writing on the blackboard is advocated for beginners, on the ground that in this way the letter shapes may be learned and produced by movements of the shoulder muscles, and that these muscles are much less easily fatigued than the muscles controlling finger movements.

Another method of forming the letters is possible when the arm is supported as under the ordinary conditions of writing. By this method the letters are also formed by movements of the arm as a whole, but chiefly of the fore-arm, the pivot in this case being the large muscle of the fore-arm on which it is resting. This movement of the fore-arm, by means of which the backward and forward movement of the pen as well

as the circular movement may be made without involving any finger movement, is known popularly as arm-movement or muscular writing. These movements are produced by the muscles in the part of the arm between the elbow and shoulder.

Finally, the form of the letters may be produced by movements of the fingers alone. Here the form is produced by varying degrees of pressure and relaxation of the fingers as they coöperate to make the up-and-down strokes and the various slants and curves.

For example, a downward stroke is made mainly by the pressure of the first finger against the pen, while the thumb and second finger guide. If additional pressure is exerted by the second finger the line will deviate to the left. To produce a curve such as that of the downward stroke of the *c* there must be an excess pressure exerted first by the second finger and then by the thumb. When the stroke reaches the bottom, the first finger must relinquish the chief rôle, which then passes to the thumb. If the next upward stroke forms the first stroke of an *e*, for example, the middle finger first gives way and then presses against the thumb to form the loop at the top. On the other hand, if the next letter is the *m*, the second finger exerts a somewhat stronger pressure during the upward stroke and then releases it at the top. Such is the ever-shifting balance of forces by which the apparently simple writing movement proceeds. It is not to be wondered at that the child's pen runs off the track, and the precision of the adult writer is only to be

ascribed to the wonderful efficiency of an act that has become a habit through long practice.[1]

Arm movement vs. finger movement. — The relative advantages of the use of finger and arm movements to produce the forms of letters is a question on which as yet there cannot be said to be unanimity of opinion. Some experts hold that finger movements should be totally excluded if writing efficiency is to reach its highest level. It is held that finger movements are fatiguing and that those who do most writing learn this and tend to eliminate the fingers from the work of writing except for the purpose of holding the pen-holder.

Against this view it may be urged that the fingers are more adapted for making such finely graded movements as those leading to letter formation than are the coarse, heavier muscles. Children naturally, when uninstructed, use the fingers for this purpose, and it is almost impossible to get them to use the arm movement at the age when they usually begin to write. Furthermore, relatively few pupils ever succeed in entirely eliminating finger movements, and many of those who do fall back into the old habit as soon as the period of special training has passed.

Carrying the arm across the page. — Next in importance to the movement of the fingers or arm, or both combined, to produce the form of the letters, come the

[1] Freeman, F. N. The Psychology of Handwriting.

movements that carry the hand forward across the page. These movements may be made by the forearm, with the elbow as the center of rotation of the movement, or with the muscle on which the arm rests as the center. Another method found in many writers is that of lifting the arm and thus shifting it along. Authorities are pretty well agreed at the present time that the use of the muscle pad as the pivot is the most economical method of producing this movement, since it can be made in this manner without interrupting the continuous progress of the writing.

Pronation. — Still another movement enters directly into the writing activity. It is clear that the hand must not simply move across the page with either the elbow or muscle pad as the center of the movement, for if it does it cannot keep the writing on a level line, nor can a uniform slant of the writing be maintained. The only way to accomplish these results without lifting the arm is by the movement of pronation. As the hand proceeds from left to right, in the writing of most adults it tends to rotate in such a way as to keep the hand always prone or flat.

Good writing rhythmical in character. — Besides these actions, which are more directly present in bringing about the writing results, there are many other muscular activities indirectly concerned, such as those of keeping the body in the proper position. Before the writing habit is perfected all of the muscular activities must be properly coördinated. Nothing is

more characteristic of the beginner's writing movements than this lack of coördination. The child's effort to produce results is accompanied by a very general state of muscular tension. The discharge of nervous impulses is at first in part into muscles that have no relationship to the production of the writing movement. Many children roll their heads from side to side, press their feet strongly against the floor, or even make tongue movements while they are writing. As the habit becomes more ingrained these movements tend to disappear. Again, the movements more directly concerned in the writing are at first incoördinated. Instead of making the sweeping, continuous movement of the adult, the child proceeds by a series of intermittent short movements. Even single strokes of letters require separate movements for their production in many cases, whereas with the adult the whole word or in some cases phrases are written without any interruption to the onward flow of the writing.

Careful studies of the writing of adults show that the more efficient writers in reality proceed by a series of rhythmical actions, and this is perhaps the most characteristic difference between the writing of the adult and that of the child. Devices to help the child to acquire this rhythmical motion, such as counting, etc., further the child's progress in extending the writing unit.

Usefulness of writing scales. — Recent investigations of writing by means of standard tests and the

use of writing scales have done much to put the subject of writing instruction on a more scientific basis. Such investigations have banished the belief that slow, laborious writing movements, resulting in beauty of form, are worth being cultivated. The aim in writing is the production of legible characters at an efficient speed and with economy of effort. Even with respect to speed, instruction in writing may become too formal. It can scarcely be doubted that the advice of Thorndike that pupils be released from writing instruction and allowed to devote the time to learning typewriting, after they have reached a reasonable degree of proficiency in speed and form, is sound.

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CHAPTER XIX

ARITHMETIC

Numbers illustrate abstract thought. — The psychology of arithmetic affords a splendid illustration of the nature and use of abstract thought. The number relationships that we apply to objects can scarcely be said to be properties of the objects themselves. They are rather ideas or concepts that the mind constructs in order to think of objects in certain useful ways. In this respect number relationships differ very much from the colors and other sensory qualities of objects. We apply the numerical relations to the objects, but in so doing the mind rather imposes its scheme of things upon the objects, whereas the latter seem to impress their sensory qualities from without.

Number ideas have developed gradually. — Accordingly, number ideas have been evolved very gradually under the impetus of practical usefulness, and in the end complex relationships are worked out that are so purely abstract as to be believed to be true wholly apart from any application to objects. Number is thus an abstract system of relationships constructed by the mind because of its usefulness in thinking of things in this way.

The history of the gradual evolution of number

systems gives a fascinating picture that well illustrates how man has progressed in his conquest of nature and in the art of perfecting social relationships. This has been due to his capacity to form ideas and hand them down from generation to generation, with gradual accretions by means of language.

The earliest form of appreciation of quantitative relationships is merely a vague feeling of more or less, which it is probable even the lower animals possess. Sometimes this is the direct result of the perception of the difference in size of spatial magnitudes; but in other cases, where there is a series of similar temporal events, it approximates counting. Thus, two series of taps may be distinguished from one another as longer or shorter even without recourse to actual counting.

Counting began by tallying. — There is much evidence to show that counting originated by means of a system of tallies. Vague impressions of differences in size are not suitable to the practical demands of life. If a person has a large flock of sheep, the loss of one is not likely to be known unless some sort of counting is resorted to. Man began, therefore, under such circumstances to lay aside certain objects such as pebbles (compare calculate, from Latin *calcul*—a stone), which were easily manipulated, one for each object that was to be counted. It was natural that the fingers should be used frequently as a convenient means of tally, and it is undoubtedly due to this fact that our number system is a decimal system.

Tallying is thinking in symbols. — The important aspect of tallying from the psychological point of view, however, is that here we are dealing with the beginnings of that abstract mode of thinking which gradually became more and more abstract in character, and finally developed into the complex series of number relationships that we now possess. When primitive man had come to the point where he laid aside objects of one sort to represent or symbolize others, he had come to realize that for purposes of his own thinking he could treat the one set of objects as if they were the other.

Counting arises from putting objects and symbols in related series. — Connected with this process of symbolizing one group of things by another is a further process which is at the root of the appreciation of all number relationships. It is not only as a mass that the group of pebbles represents the flock of sheep, but each pebble stands for a particular sheep, if both pebbles and sheep are arranged in order and no pebble or sheep is thought of more than once. The next step naturally follows as soon as this is recognized. Objects are not necessary for symbols. Words will accomplish the same purpose much more conveniently. A name is given to each position of the individual member of any group of objects when arranged in a series. Thus arose counting, which is merely placing each object over against the series of number names each of which stands for a definite place in the series.

Counting implies considerable abstract thought, for

it means that attention selects out the single aspect of order and disregards all the other characteristics of the objects. Accordingly, we find that some primitive tribes have not developed number names beyond three or four, and frequently are unable to grasp number relationships beyond this point.

Advantage of Arabic system over Roman. — In counting more than ten on the fingers the same fingers must be used a second time, and it is natural to use them in the same order as in counting the first ten. Hence arises the conception of the second ten being merely a second group of the same sort as the first. The Arabic system takes ingenious advantage of this fact by giving to each position in the second series the same name and symbol as it has in the first series of ten and indicating the number of tens by placing two in front of the units number and so on for each succeeding series of ten. The Roman system failed to obtain flexibility and ease of manipulation by reason of the absence of the zero in representing ten.

The fundamental operations come from various methods of grouping. — Further manipulation of numbers beyond this point in the form of the simple arithmetical processes takes place by grouping. Eight may be divided into two groups of seven and one, six and two, five and three, etc. If these groups are conceived as coming together we have the process of addition; if one of them is conceived as being split off from the main group we have the process of subtraction.

In multiplication and division we are dealing with equal groups. If the equal groups are thought of as being placed together to form the main group we have multiplication; if they are thought of as successively split off from the main group we have division. Thus dealing with numbers becomes more and more abstract. Beginning with a definite reference to objects, a way of thinking has been reached that gives us a series of relationships which may be manipulated in thought in various ways without any reference to objects. Finally, in algebra a still more abstract system arises in which the symbols are even more general and do not stand for any definite order in the number series.

Early number ideas of children. — What the race has achieved by a slow and gradual process the child now is able to acquire in a relatively short time, because it is handed down to him ready-made. The earliest beginnings of anything akin to number consciousness in the child come in connection with the recognition of gross differences of more or less which are based on the perception of size. The missing of one or more articles from a group by a child is, of course, no clear indication of a number consciousness, but it is the first vague beginning of an ability to remember and conceive in a quantitative way. Children who learn the number names used easily learn to repeat them from one to ten in a mechanical way, though at first with no suggestion that they can count in the true sense of the word. In their first attempts at counting

children frequently point to the same object more than once, showing that the principle of serial arrangement is but vaguely apprehended. While in many cases children are able to count accurately on entering school, the statement is made that on the average six-year-old children do not comprehend beyond three or four.

Usefulness of objective methods limited. — The natural procedure in further development of the child's ideas of number when he enters school is by perfecting his ability to count. The degree to which this as well as all other phases of arithmetical operations should be developed by means of objective methods of teaching will be determined by a correct understanding of the nature of the psychological principles of the number consciousness. As we have seen, numbers are concepts that to a peculiar degree are capable of being treated as if entirely independent of objects. On the other hand, like all concepts, they find their origin in the concrete experiences of life and find their application there. Accordingly, it is unnecessary to teach every arithmetical fact objectively. Only so much of objective teaching is necessary as to develop correct concepts and to enable the child to make correct application to concrete objects. It is relatively easy, for example, for the average child who has noted objectively that 5 and 3 are 8 to understand the import of 6 and 2 are 8.

One form of objective teaching of number relations is that which cultivates the ability to recognize visually the number of objects in a group immediately and

without counting. If, for example, dots are used as the objective material and these are arranged in similar groups, large numbers may be recognized at a glance after a little practice. Thus the following groups may be readily recognized immediately as representing twenty-two:

```
•   •   •   •   •   •   •   •   •
  •       •       •       •
•   •   •   •   •   •   •   •   •
```

The claim is made that children are more positive in their fundamental operations if this ability to grasp groups of counters visually presented has been developed as sharply and completely as possible. The reason for this seems to be that such training aids in the thorough apprehension of the various grouping relationships, which, as we have seen, lie at the basis of the fundamental operations.

Fundamentals must be made automatic through drill. — As long as the child has to resort to objective demonstrations of number relations, however, number remains a clumsy and ineffective device. The main aim in teaching children the fundamental operations of arithmetic is the formation of habits of unvaryingly accurate and immediate response to all of the forms in which numbers may be combined. This can be accomplished, as in the case of all habit, only by constant repetition or drill. If the drill can be relieved from monotony by variations of method, so much the better; but the repetition itself is essential.

The art of calculation does not require that the reasons for each step be understood. — For a similar reason to that which makes too great an emphasis on objective teaching of arithmetic unwise, it is also unwise to be too insistent that the child understand thoroughly the reasons for all the steps he takes in his various calculations. The dictum that a child should be taught to understand wherever possible does not mean that he must never be taught what he cannot understand. Probably a very small proportion of persons who are able to perform the steps of the process of subtraction understand thoroughly the reasons for the device of borrowing. To arrive at the result promptly and accurately is the essential thing. So true is this that it might almost be said that some children understand the arithmetical relationships too thoroughly. Brighter children frequently hit upon the device of getting at results in an indirect way. Certain of the number combinations, for reasons not well understood, are remembered less easily than others. Thus a child may know immediately that $8 \times 8 = 64$, but not what is the result of 8×9. Accordingly, if asked to multiply 9 by 8 he arrives at the result indirectly, thus: $8 \times 8 = 64$; $64 + 8 = 72$. Obviously, habits of this sort do not make for efficiency, but they frequently persist and are even resorted to in adult life. So, too, if it is known that $8 \times 9 = 72$, it is easy for the child to see that $9 \times 8 = 72$; but as long as

the process of reversal is resorted to, the habit falls short of the perfection to be desired.

Combinations need to be drilled in all their various forms. — The need for making every possible number combination in addition, subtraction, multiplication, and division carry with it an automatically correct response extends beyond the simple combinations to the various complex forms in which they may be presented. Courtis has shown, for example, from the results of extensive tests, that single column addition of three figures each requires a different series of habits from those needed in adding thirteen figures to the column. Indeed, Courtis, on the basis of these tests, enumerates seven different forms that addition may take, three for subtraction, six for multiplication, and nine for division. Each of these complex typical forms needs to be drilled as if an entirely separate operation.

Problem-solving involves deductive reasoning. — Problem-solving in mathematics affords the one example of purely deductive reasoning of the ordinary school. The value of training in the solution of problems is, or should be, twofold. In the first place, ability to solve arithmetical problems through the process of reasoning is of practical value to the degree to which these problems are met with in life outside of the school. Such problems can be solved in a purely mechanical way without the proper understanding for the reasons underlying the various steps in the process. For example, the application of the principle of per-

centage to interest, discount, etc., may be made through the use of memorized formulæ the derivation of which is not understood. The person who solves problems by such merely mechanical methods is, however, at a disadvantage in a number of ways. He puts an undue burden on his memory which a resort to reasoning would make unnecessary. He runs the risk continually of mistaking the formula that should be applied to the particular instance at hand. Every one who has taught arithmetic to children has observed that this difficulty is a fundamental one. The slightest deviation from the usual form in which a particular kind of problem is put, even a slight difference in wording, brings fatal results. The great advantage of reasoning is that it enables the person to discard superficial differences and seize upon fundamental principles even when the data are novel.

The purely deductive character of reasoning in arithmetic is seen from the fact that one problem thoroughly understood is of more value than piling up illustration after illustration without understanding. The latter method will indeed defeat its own end if it leads to the adoption of a mechanical form for solving such problems.

The further advantage of training in the solution of problems in arithmetic is in the impetus it gives to correct thinking in general. After reading what has been said of transfer of training effects in a preceding chapter, it will be at once recognized that this state-

ment must be made in a guarded way. In no other matters can we come to the same kind of precise and unshakable conclusions that we make in mathematics. In no other field is the reasoning of a purely deductive nature. But in solving problems in mathematics, more than at any other point in his elementary school work, the child comes to recognize the dependence of conclusions upon premises and the necessity of critically examining both the correctness of the premise and the method of arriving at the conclusion. It cannot be doubted that this attitude of critical inquiry may and should be carried over to other subjects than arithmetic, even though it is true that in many instances this does not take place.

Solving simple problems should be begun early. — The question of how early the child should be trained in solving problems has had varying answers both in practice and in theory. As we have already seen, there is no good ground for the view that reasoning is a capacity that the child acquires relatively late in life. The child before the age of entering school can reason in respect to things that come within the scope of his experience and that do not involve too long a series of steps. Undoubtedly there are very great individual differences among children, as among adults. Fundamentally, reasoning requires "sagacity," which seems to be largely a matter of inherited capacity. In general, one individual differs more from another in the more complex mental processes than the simpler.

At the same time, there is little doubt that improvement in capacity for solving problems in arithmetic would take place if more stress were laid on this training in the early grades by the use of simple material within the comprehension of the pupils.

Investigation of children's ability to solve problems. — Bonser gave a test to 757 children in the fourth, fifth, and sixth grades in Passaic, New Jersey. Each of these problems required three steps: "First, the analysis of the situation by which the essential features of the problems are conceived and abstracted; second, the recall of an appropriate principle to be applied to the abstract problem, a search among various principles which may suggest themselves for the right one, and, third, involving the second, the inference, the recognition of identity between the known principle and the new situation." Table XIV gives the most general results of the tests in terms of the median ability of each grade for boys and girls:

TABLE XIV

Grades	*Boys*	*Girls*
4 A	14.50	11.36
5 B	21.39	15.66
5 A	22.83	19.00
6 B	25.63	24.08
6 A	28.00	25.92

The capacity for solving problems clearly increases steadily from grade to grade. Bonser finds that the boys are superior to the girls in each grade, though the difference becomes increasingly smaller in the higher

grades. The results also showed that three boys of grade 4A and nine boys and four girls of grade 5B had an ability to solve these problems equal to or greater than the median boy of grade 6A.

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CHAPTER XX

CONCLUSION

THE aim of the foregoing chapters has been to show what that aspect of ourselves which we call *mind* is for, and especially to show how the answer to this question is related to the process of education. In this chapter the attempt will be made to sum up the conclusions arrived at and to consider the general significance of what has been learned. These conclusions have been implied in the earlier chapters, but may have been easily overlooked during the course of our study of details.

Biological view of man. — Man can be best understood if considered as at one and the same time a part of, and apart from, the rest of nature. Biological science calls attention to the many resemblances between the bodily structure and functions of human beings and those of the lower animals. A study of the behavior of the lower animals shows also that they are governed by the same general principles of action as in the case of man. But, while man's kinship with the lower animals cannot be questioned, and the significance of his life activities cannot be understood except in relationship to the doctrine of evolution, it

is a grave mistake to minimize the importance of the great gulf between man's nature and that of the most highly developed of the lower animals. In no respect are these differences more marked than in the various forms of learning that, taken together, form the means of education.

Psychology a biological science. — Psychology, like biology, may adopt as its fundamental conception for the understanding of man that which regards him, like all other living organisms, subject to a constantly recurring series of changes due to the necessity of adaptation to environment. All animals, including man, are provided with structures and functions that make it possible for them to lead a more or less independent existence. If the environment is not suitable or is inimicable to their needs, they may so react on it as to change it in some cases, or in others to move away into more favorable surroundings.

The biological mechanism for producing action. — There are three biological functions, which all animals possess, that are primarily responsible for the mutual action and reaction between living organisms and their environment—irritability (sensitivity), conductivity, and contractility. While all of these functions are performed by the same cell in the lowest forms of life (the unicellular animals), in the case of all higher forms than these the cells are specialized. Those cells that are specialized to perform the function of irritability are situated, for the most part, at or near the

surface of the animal's body. In higher forms of animals they take the form of special sense-organs and are differentiated so as to be affected each by a special form of environmental change—contact (touch), ether vibrations (vision), air vibrations (hearing), etc. Irritability is, then, that function by means of which environmental happenings affect living organisms. But the organism affected by an environmental happening is not merely changed thereby—it reacts. The reaction is due to the functioning of the contractile cells, which, taken together, in the case of higher animals constitute the muscular system. The contractile cells, except in the case of very low forms, can function only by virtue of their connection with irritable cells, made possible by the interposition between them of conductile cells. The conductile cells taken together form the nervous system, which is therefore a mechanism for conducting the effects (nervous impulses) of environmental changes on the various sensory parts of the body to the muscles. The goal of the entire series of changes is, therefore, muscular action—not merely muscular action, but action that is made in response to what is happening in the environment, thus serving to adapt the animal to its environment.

Consciousness an adaptive function. — Closely related to the adaptive functions already mentioned is the function of consciousness, which appears as one of the links in the chain leading from impression to reaction. At just what point in the development of the

animal series from lower to higher forms this function of consciousness makes its appearance it is difficult to say, but in ourselves we have come to recognize it as the most significant aspect of our existence. It is true that certain adaptive reactions may take place, as in the case of reflex and automatic actions, by means of the mechanism already described—the sense-organs, nervous system, and muscles—without the presence of consciousness. Conscious adaptations, however, are so complex, the muscular reactions that follow them are so frequently delayed or overlooked, that our thoughts and feelings seem to have an importance as existences in themselves, apart from the rôle they play in relation to action. Whatever may be the truth as to the ultimate nature of mind is a problem that must be left to philosophy to settle. For our present purposes it must be regarded as a function of organisms, the purpose of which is to enable its possessor to adapt his behavior to environmental conditions on a higher plane or in a more effective fashion than would be possible without it.

Non-conscious action not suitable to changing conditions. — The significance of consciousness may be understood by considering those cases of adaptive reactions that take place unconsciously. The typical cases of such reactions are the reflexes. Take, for example, the well-known pupillary reflex—the widening and contracting of the pupil of the eye in response to more or less light. Here is a mechanism clearly

adaptive in its function which operates under proper environmental conditions independently of consciousness. One of the main characteristics of this reaction, and of all reflex action, is its invariableness. Given the proper stimulus, the reaction follows inevitably and in the same manner.

Inadequacy of reflex action. — Animals low in the evolutionary scale exhibit a type of behavior that is almost purely reflex. Their life conditions are relatively simple and unchanging. It is conceivable that the higher forms of life might have been constructed on the same plan, with a purely reflex response to adapt them to every condition that the changing and complex environment would present; but such an animal would require a piling up of reflex mechanisms to a degree making the nervous systems of the higher forms of animal life so intricate and complex that such a method of adaptation is scarcely more than conceivable. Obviously, the more varied and complex the environmental conditions to which an animal must respond, and the more necessary it is to respond to the ever-recurrent changes of environmental conditions, the less suited is the invariable form of response for the purpose.

Significance of the modification of instincts. — Accordingly, we find a somewhat higher type of response added to the equipment of most forms of animals— the instinctive. While the instinctive reaction is closely allied to the reflex, it is more complex and,

especially important from the point of view of our study, it is more likely to become modified than is the reflex. While the instinctive reaction as such is invariable, it may be gradually modified so as to conform to changes in environmental conditions. Here, then, we have the simplest form of learning, that is, the modification of existent forms of response so as to meet the requirements of life conditions different from those for which the instinctive responses were created.

Instincts accompanied by simpler forms of consciousness. — The instincts are accompanied by a form of consciousness—the emotional—that seems primarily for the purpose of furnishing the "drive" or "urge" for the performance of the instinctive action as such; but the more elementary feeling component of pleasure-pain which is also present, seems more closely related to the modification of the instinctive response.

Trial-and-error learning as a form of conscious adaptation. — Even in low forms of animal life there is another kind of learning in addition to the modification of instincts. Most animals, when confronted with a situation that is strange and unfamiliar, that is, a situation for which the usual modes of response are not adequate, will behave in a way that is in strong contrast with the instinctive mode of response. Instead of a clearly purposeful and related series of acts, as in the case of instinctive action, there is under such circumstances a large number of apparently useless and unrelated acts. By the trying out of these various

acts one may be found that leads to a satisfactory result. A repetition of a similar unfamiliar situation calls forth similar "hit-or-miss" reactions; but each time the repetition takes place the successful action becomes more prominent and the unsuccessful tends to be eliminated. In time the response becomes immediate and definite, as in the case of the instinctive reaction. A habit has been formed by a process of "trial-and-error" learning, and the situation is no longer unfamiliar but one to which the animal has become adapted through experience.

In human beings the trial-and-error form of learning is accompanied by that form of consciousness which we call perception and feelings of pleasure in the satisfactory result, and of displeasure in those actions the results of which are unsatisfactory.

The rôle of consciousness in the foregoing forms of learning seems to be limited to the awareness of objects in the environment (perception), together with emotions and feelings that spur and restrain action. Something of the nature of memory must also be present, since the effects of one experience must be retained in order that modification or learning may take place. Psychology, however, prefers to reserve the word "memory" to designate those forms of retention where there is a conscious *recognition* of the "pastness" of an experience, and in this sense memory is not a necessary accompaniment of the forms of learning thus far described.

Ideational learning is on a higher plane. — It is in the case of ideational learning, which involves all the higher forms of intellectual processes—memory, imagination, and thinking—that the rôle of consciousness becomes most prominent. While it is perhaps too extreme to say that man is the only animal whose behavior is governed by ideas, it is at least true that because of the extent to which man uses this type of learning there is a very great difference between his adaptive behavior and that of the lower animals. The development of consciousness reaches its highest significance in the intellectual life of human beings.

Function of language. — Language is both a means of development of ideas and a means of conserving ideas and conveying them from one individual to another. It is only by this means that the progress of the human race has been preserved and accelerated. Each generation adds its quota of ideas to those of preceding generations and hands them down to the next generation by means of language. The period of education is the period during which the youth of one generation is acquiring the most fundamental ideas of the past. These ideas have gradually been arranged and systematized into subjects of study.

Evidence remains that there existed on the earth many thousands of years ago human beings whose physical development was fully equal to that of the best developed races of to-day. Furthermore, as far as can be told from the shape and size of the skull

the mental capacity of some of these races must have been equal to that of people of to-day. If, therefore, progress has taken place during the intervening time, it is not because people differ fundamentally from those of the earlier period, but simply because each generation has been able to acquire the achievements of past generations and build on these foundations. Thus, by a process that has been aptly called *social heredity,* man preserves the learning of the past and is able to build upon this foundation for the future.

The meaning of infancy. — Education, therefore, becomes a necessity both for the individual and for society. Primitive society, with its relatively small stock of ideas and accomplishments, can afford to educate the young by the more informal means of imitation and direct oral instruction of parents and children. But as society and its institutions and activities become more complex, organized means of instruction become necessary, and hence arise institutions for the *formal* instruction of the young. During this period the young must remain in a state of infancy, that is, of economic dependence on the parent. As Butler has said, in summarizing Fiske's "Meaning of Infancy":

> The entire educational period after the physical adjustment has been made, after the child can walk alone, can feed itself, can use its hands, and has, therefore, acquired physical and bodily independence, is an adjustment to what may be called our spiritual environ-

ment. After the physical adjustment is reasonably complete, there remains yet to be accomplished the building of harmonious and reciprocal relations with those great acquisitions of the race that constitute civilization; and therefore the lengthening period of infancy simply means that we are spending nearly half of the life of each generation in order to develop in the young some conception of the vast acquirements of the historic past and some mastery of the conditions of the immediate present.

APPENDIX

The material of this Appendix is presented to the student for the purpose of giving him a clearer understanding of the nature of various forms of tests. It consists of (a) A general intelligence test; (b) A standardized silent reading test, and (c) A standardized arithmetic test. Taken together these tests constitute the so-called Illinois Examination, devised by the Bureau of Educational Research of the University of Illinois and given extensively to pupils of public schools in Illinois and elsewhere. The forms of the tests presented here are used for grades VI, VII, and VIII. Other forms have been devised for grades III, IV, and V. Copies of the tests and a handbook of directions for giving and scoring the tests, etc., may be purchased from the Public School Publishing Co., Bloomington, Ill.

Illinois Examination II
For Grades 6, 7, and 8

Form 1
Second Edition,
September 1920

UNIVERSITY OF ILLINOIS
Urbana, Illinois
BUREAU OF EDUCATIONAL RESEARCH

General Intelligence, Operations of Arithmetic and Silent Reading

Name .... Boy or Girl..............

Age last birthday.................... Next birthday will be..........................19......

Grade .... Date .... City .... State ....

School .... Teacher ....

WRITE PUPIL'S SCORES HERE

General Intelligence		Operations of Arithmetic		Chronological Age			
Test	Score	Test	Score	Silent Reading			
					Score	A. A.	A. Q.
1.		1.					
2.		2.		Rate			
3.		3.		Comp.			
4.		4.		Average			
5.		5.					
6.		6.					
7.		7.					
		Cor.	16				
Total		Total					
Mental Age		Achievement Age					
I. Q.		A. Q.					

General Directions

This booklet contains a number of tests. You will be shown them one at a time and will finish each one before you see the next one. Read the directions for each carefully and when the signal to begin is given turn the page and do the tests as rapidly as you can but remember that it is important to get them right.

Do not turn a page until you are told to do so.

Directions for Test No. 1—ANALOGIES

Look at this line: (a) sky, blue, grass—**table, green, warm, big.**

Notice the four words in heavy type. One of them—green—has a line drawn under it. Grass is green just as the sky is blue.

Look at line (b) below: A fish swims and a man does what? Draw a line under the one word of the four in heavy type which tells what a man does.

Now look at line (c). Night means the opposite of day. What word means the opposite of white? Draw a line under it.

(b) fish—swims::man—**paper time walks girl**
(c) day—night::white—**red black clear pure**

On the next sheet are some exercises like these. The first two words in each line are related to each other in some way. Draw a line under the word in heavy type that is related in the same way to the third word. Begin with the first line and do as many as you can before time is called. Only one word in each line is to be marked.

Test No. 1—ANALOGIES

No. Right ....

1 eat—bread :: drink—water iron lead stones.................... 1
2 finger—hand :: toe—box foot doll coat........................ 2
3 shoe—foot :: hat—kitten head knife penny..................... 3
4 dress—women :: feathers—bird neck feet bill.................. 4
5 dog—puppy :: cat—kitten dog tiger house...................... 5
6 sit—chair :: sleep—book tree bed see......................... 6
7 foot—man :: hoof—corn tree cow hoe........................... 7
8 handle—hammer :: knob—key room shut door..................... 8
9 chew—teeth :: smell—sweet stink odor nose.................... 9
10 bird—song :: man—speech woman boy work...................... 10
11 sailor—navy :: soldier—gun private army fight............... 11
12 legs—frog :: wings—eat swim bird nest....................... 12
13 man—home :: bird—fly insect worm nest....................... 13
14 camp—safe :: battle—win dangerous field fight............... 14
15 water—fish :: air—spark man blame sleep..................... 15
16 pan—tin :: table—chair wood legs dishes..................... 16
17 tiger—wild :: cat—dog mouse tame pig........................ 17
18 hospital—patient :: prison—cell criminal bar jail........... 18
19 floor—ceiling :: ground—earth sky hill grass................ 19
20 feather—float :: rock—ages hill sink break.................. 20
21 airplane—air :: submarine—dive engine ship water............ 21
22 cold—heat :: ice—steam cream frost refrigerator............. 22
23 framework—house :: skeleton—bones skull grace body.......... 23
24 carpenter—house :: shoemaker—hatmaker wax shoe awl.......... 24
25 pretty—ugly :: attract—fine repel nice draw................. 25
26 hour—day :: day—night week hour noon........................ 26
27 clothes—man :: hair—horse comb beard hat.................... 27
28 darkness—stillness :: light—moonlight sound sun window...... 28
29 blow—anger :: caress—woman kiss child love.................. 29
30 imitate—copy :: invent—study Edison machine originate....... 30

Directions for Test No. 2—ARITHMETIC PROBLEMS

On the next sheet there are a number of Arithmetic problems. Get the answers to them as quickly as you can. Write each answer after the word "answer," as in the problem below.

> Mary had 5 apples and gave two to her brother.
> How many had she left?..................Answer (3)

Test No. 2—ARITHMETIC PROBLEMS

No. Right ....

1	If one boy has 10 fingers, how many fingers have six boys?	Answer ( )
2	There are 15 children in our class. 5 of them are boys. How many are girls?	Answer ( )
3	We learn 2 words a day in our class. How many do we learn in 8 days?	Answer ( )
4	Jack is 42 inches tall and Fred is 5 inches taller. How tall is Fred?	Answer ( )
5	Mr. Gray sold ten bags of flour last Saturday at 2 dollars a bag. How many dollars did he get for the flour?	Answer ( )
6	Anna, Lizzie, Sarah, and Carrie shared 20 plums equally. How many plums did each get?	Answer ( )
7	After giving 9 cents for some candy, Helen had 2 dimes remaining. How many cents did she have at first?	Answer ( )
8	A baseball team took 12 players on a trip. The trip cost the team $36. How much was that for each player?	Answer ( )
9	At the rate of a mile in two minutes, it takes 30 minutes to run from one station to another. How many miles apart are the stations?	Answer ( )
10	Ned sold his rabbit for 30 cents. This was 3/5 of what he paid. What did he pay for the rabbit?	Answer ( )
11	In a trolley car there were 29 people. At the first stop 8 got off and five got on; at the second stop 13 got off and ten got on. How many were in the car then?	Answer ( )
12	How many cakes at seven for 10 cents can I buy with half a dollar?	Answer ( )
13	Albert had $1.50. He spent 1/5 of it for a bat. How much money had he left?	Answer ( )
14	Oil was bought for 10c a gallon and sold for 3c a quart. Find the gain on 32 gallons	Answer ( )
15	Books were marked $1 each. Later the price was reduced 30 cents. Find the cost of 5 books at the reduced price	Answer ( )
16	A merchant buys ½ dozen handsaws at $16 a dozen. How much must he receive for the lot in order to gain fifty cents apiece?	Answer ( )

Directions for Test No. 3—SENTENCE VOCABULARY

Look at this exercise:

Apples grow on **vines roots grass trees.**

The right word is **trees** because it makes the truest sentence.

In each of the exercises below you have four choices for the last word. Only one of them is correct. In each sentence draw a line under the one of these four words which makes the truest sentence.

People can see through **wood stone glass iron.**
The **ear** is a part of the **legs arms head feet.**
Deserts are crossed by **horses mules camels elephants.**

On the next sheet are a number of exercises like these. Begin with the first and do as many as you can in the time allowed.

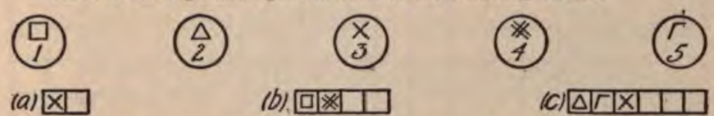
Test No. 3—SENTENCE VOCABULARY

No. Right ....

1. A gown is a string animal dress plant.
2. Haste is hurry red little sweet.
3. To tap is to run fall knock smile.
4. A dungeon is open bright heavy dark.
5. Majesty refers to dresses kings countries climates.
6. Nerves are found in the ground sky skin hair.
7. Plumbing is made of rubber glass fruit pipes.
8. A man is afloat in a mine tower boat hospital.
9. Pork comes from pigs sheep cows calves
10. A guitar is used to make toys glass music furniture.
11. A reception is a show party game sleep.
12. To snip is to cut sew paste tie.
13. Staves are used in scales barrels painting golf.
14. To regard is to magnify neglect understand consider.
15. Skill is keenness anger grief expertness.
16. Disproportionate amounts are rough unequal fair equal.
17. Mars is a planet country goddess actor.
18. A selectman is a confederate officer conspirator lawyer.
19. Coinage refers to seignior bonds currency coincidence.
20. A forfeit is a penalty gift valley find.
21. To bewail is to applaud lament beware laugh.
22. A fen is a upland bushland waste marsh.
23. To tolerate is to tax multiply record permit.
24. To be sapient is to be savory wise sardonic questionable.
25. A milksop is a flirt pudding prude mollycoddle.
26. The lotus is a lout poison water-lily bird.
27. To drabble is to soil excite crowd twaddle.
28. Ochre is a nostrum pigment stone monster.
29. Ambergris is used in candles fishing medicine perfumery.
30. A harpy is a hobby monster litany harpist.

Directions for Test No. 4—SUBSTITUTION

Look at the sign and figure in each of the following circles:

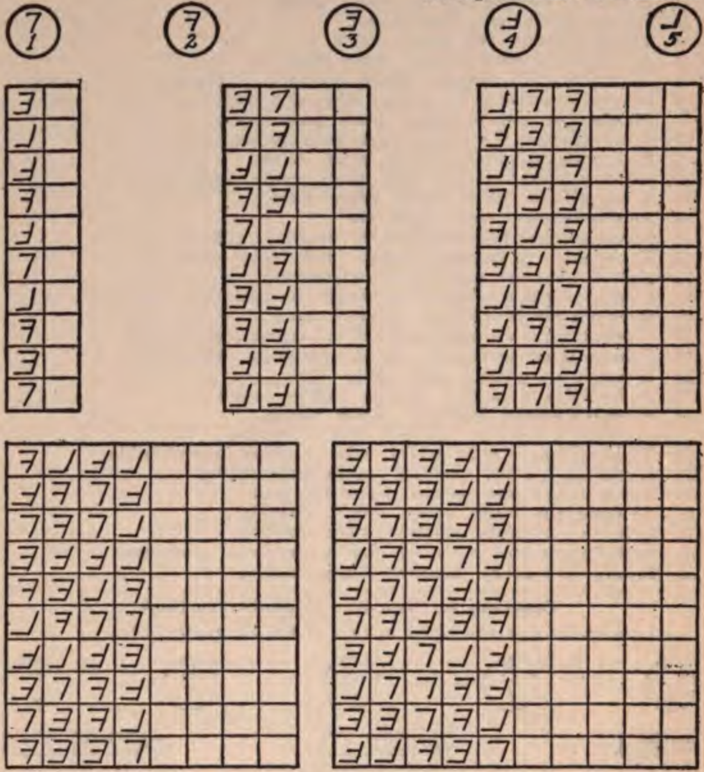


Under the circles are some exercises having the same signs. Look at the exercise (a). Find the circle in which this sign is printed. The figure 3 is in the same circle. This means that the sign in exercise (a) stands for 3. Write the figure 3 in the square next to the sign to which it belongs.—Look at exercise (b). There are two signs in this exercise. Find the figure which is in the same circle with the first sign. Write this figure in the first blank square.—Do the same for the second sign.—Look at exercise (c). Write the figures for these signs in the three blank squares. Write them in the order that the signs come.

On the next sheet are some different signs in circles and below the circles these signs are again printed. Write after each sign or group of signs the figures which belong to the signs. Look back at the circles as often as you need to. You can work faster after you have learned the figure that goes with each sign. Begin with the first sign and write as many numbers as you can in the time allowed.

Test No. 4—SUBSTITUTION

No. Right........... ÷ 4 = ...



Directions for Test No. 5—VERBAL INGENUITY

Look at line (a) below. The words of this line are "see a I man on." In this order the words do not make sense but they can be made into a sentence if you leave out one word. The sentence is "I see a man." The word to be left out is on. Draw a line through it. In each of the other lines when one word is crossed out, the remaining words can be made into a true sentence. Cross out the extra word in each line.

(a) see a I man on.
(b) knife chair the sharp is.
(c) John broken window trees has the.

On the next sheet there are a number of exercises just like these. Cross out the extra word in as many of the exercises as you can. Remember that only one word in each line is to be crossed out.

Test No. 5—VERBAL INGENUITY

No. Right ___________

1 the cat at see.
2 boy was sky the sick.
3 Bread sweep will the kitchen I.
4 are going yesterday to-morrow we.
5 me mine give my straw hat.
6 brown the horse come is.
7 my suit dollars wear twenty cost new.
8 know ice big boys how skate to.
9 their soldiers for fight gun country.
10 teacher me from gave a pencil my.
11 brother lamp is my than I older much.
12 dusty road the is hot and miles.
13 in the chalk he brightest is boy class our.
14 house hard to is climb very the hill.
15 broke his robin the flew little poor wing.
16 gave me candy brother my of knife a box.
17 the flood roaring valley came bridge the down.
18 the song birds flown during the to have south.
19 boy gold watch brightest over get the will a.
20 I not Monday do to bag like go to school on.
21 watch summer the man stole is jail who the in.
22 old back only the chair legs has three.
23 told girl I I the to would her with home walk.
24 man whom the hat saw is you uncle my me with.
25 do not boy the I like who me school in sits desk behind.

Directions for Test No. 6—ARITHMETICAL INGENUITY

Look at line (a) below. The numbers 2, 4, 6, 8, 9, 10, 12 count up by two's except the number 9. It is the number which does not fit in this group Cross it out. In each of the other lines there is one number that does not fit. Find this number and cross it out.

(a)	2	4	6	8	9	10	12
(b)	7	6	5	1	4	3	2
(c)	1	2	4	8	16	17	
(d)	1	3	5	7	2	9	11

On the next page there are a number of exercises just like these. Do as many as you can in the time allowed. Remember that only one number in each line is to be crossed out.

Test No. 6—ARITHMETICAL INGENUITY

No. Right ________

(1) 1 2 3 9 4 5
(2) 2 4 6 7 8
(3) 9 8 7 6 5 2
(4) 11 10 8 6 4 2
(5) 5 7 10 15 20 25
(6) 3 6 9 11 12 15
(7) 19 18 17 16 13 15 14
(8) 4 8 12 14 16 20 24
(9) 16 8 4 3 2
(10) 2 4 8 16 24
(11) 27 24 21 19 18 15 12
(12) 1 3 5 7 9 10 11
(13) 2 4 8 10 16 32
(14) 4 9 14 19 24 29 33
(15) 2 3 6 12 24
(16) 21 17 13 9 5 3 1
(17) 36 18 9 3
(18) 1 5 9 11 13 17
(19) 1 3 9 18 27
(20) 27 22 17 14 12 7
(21) 3 9 27 54 81
(22) 72 36 18 9 6
(23) 84 77 70 65 63 56
(24) 3 9 15 21 24 27
(25) 3 6 9 12 24 48

Directions for Test No. 7—SYNONYM-ANTONYM

Look at these exercises:

(a) good—bad .... same opposite
(b) little—small ....same opposite
(c) rich—poor ....same opposite

In exercise (a) good means the opposite of bad. This is shown by a line drawn under the word opposite. In exercise (b) little means the same as small. Would you draw a line under same or opposite? You would draw it under same. In exercise (c) do rich and poor mean the same or opposite? Draw a line under same or opposite to show your answer.

On the next sheet there are a number of exercises like the ones you have just done. If the words of a pair mean the same or nearly the same, draw a line under same. If they mean the opposite or nearly the opposite draw a line under opposite. Remember you are to draw a line under only one word in each line.

Test No. 7—SYNONYM-ANTONYM

No. Right ....

No. Wrong ....

Difference ....

1 high—low .... same—opposite 1
2 go—leave .... same—opposite 2
3 large—great .... same—opposite 3
4 bitter—sweet .... same—opposite 4
5 begin—commence .... same—opposite 5
6 accept—take .... same—opposite 6
7 find—lose .... same—opposite 7
8 expand—contract .... same—opposite 8
9 shrill—sharp .... same—opposite 9
10 fault—virtue .... same—opposite 10

11 command—obey .... same—opposite 11
12 tease—plague .... same—opposite 12
13 similar—different .... same—opposite 13
14 delicate—tender .... same—opposite 14
15 careless—anxious .... same—opposite 15
16 diligent—industrious .... same—opposite 16
17 masculine—feminine .... same—opposite 17
18 concede—deny .... same—opposite 18
19 linger—loiter .... same—opposite 19
20 accept—reject .... same—opposite 20

21 vanity—conceit .... same—opposite 21
22 appeal—beseech .... same—opposite 22
23 docile—refractory .... same—opposite 23
24 knave—villain .... same—opposite 24
25 confer—grant .... same—opposite 25
26 acquire—lose .... same—opposite 26
27 compute—calculate .... same—opposite 27
28 repress—restrain .... same—opposite 28
29 depressed—elated .... same—opposite 29
30 hoax—deception .... same—opposite 30

31 reverence—veneration .... same—opposite 31
32 vilify—praise .... same—opposite 32
33 accumulate—dissipate .... same—opposite 33
34 apathy—indifference .... same—opposite 34
35 contradict—corroborate .... same—opposite 35
36 comprehensive—restricted.. same—opposite 36
37 assiduous—diligent .... same—opposite 37
38 amenable—tractable .... same—opposite 38
39 suavity—asperity .... same—opposite 39
40 encomium—eulogy .... same—opposite 40

Test II
Form I

Rate ________ ÷ 17 = ______

Comprehension ____ ÷ 4 = ______

MONROE'S STANDARDIZED SILENT READING TEST

Second Edition, September, 1920

FOR

Grades 6, 7 and 8

Below there are three exercises. Under each exercise there is a row of words printed in bold faced type. Each exercise asks a question. You are to read each exercise and then answer the question by drawing a line under the right word printed in the black type.

Read the following exercises:

(a) I am a little dark-skinned girl. I wear a slip of brown buckskin and a pair of soft moccasins. I live in a wigwam. What kind of a girl do you think I am?

Chinese French Indian African Eskimo

The answer to this exercise is "Indian," so draw a line under Indian.

(b) Spring is the time for planting seeds. They grow fastest in summer. Autumn is the harvest time. When are seeds put into the ground?

Spring Summer Autumn Winter

The answer to this exercise is "Spring." Draw a line under Spring.

(c) In the sunny land of France there lived a sweet, little maid named Piccola. Piccola's father was dead, and her mother was very poor. Draw a line under the word below that tells in what country Piccola lived.

Germany Russia France England

On the three following sheets there are a number of exercises like these to be read and answered. When the signal is given, turn over this page and begin. Work rapidly but remember that your answers must be right in order to count. Remember that you are to draw a line under only one word in each exercise.

1. It was the garden-land of Antioch. Even the hedges, be-
9 sides the lure of shade, offered passers-by sweet promises of wine
20 and clusters of purple grapes. Over melon patches, and through
30 apricot and fig tree groves, and groves of oranges and limes, the
42 whitewashed houses of the farmers were seen.

49 What kind of land was this?

55 **barren hilly productive infertile desert**

---

60 2. It was cold, bleak, biting weather; foggy withal; and he
70 could hear the people in the court outside go wheezing up and
82 down, beating their hands upon their breasts and stamping their
92 feet upon the pavement-stones to warm them.

99 What kind of picture does this paragraph describe?

107 **comfortable luxurious cheerless pleasant exciting**

---

112 3. "I," said the duck, "I call it fun,
120 For I have my little red rubbers on.
128 They make a cunning three-toed track
134 In the soft, cool mud. Quack! quack!"

141 Draw a line under the word which tells what the duck likes.

153 **snow sunshine rain wind ice**

---

158 4 The dog lay down. The rooster few to the top of a tree
171 and the cat climbed to one of the branches. Before they went to
184 sleep the rooster saw a light in the forest. He called to his friends.
198 Where was the light the rooster saw?

205 **sky house barn wagon forest**

---

210 5 Shut in from the world without
216 We sat the clean-winged hearth about,
222 Content to let the north wind roar
229 In baffled rage at pane and door.
236 While the red logs before us beat
243 The frost back with tropic heat.

249 Draw a line under the word which best describes these people.

260 **frightened cold contented hungry gloomy**

---

265 6 O suns and skies and clouds of June,
273 And flowers of June together,
278 You can not rival for one hour
285 October's bright blue weather.

289 Which month does this stanza say is the more pleasant?

299 **April September June May October**

(Turn to next page.)

304 7. Her couch was dressed here and there with some winter
314 berries and green leaves, gathered in a spot she had been used to
327 favor. "When I die, put near me something that has loved the
339 light, and had the sky above it always."

347 What had the girl loved most?

353 **pretty clothes nature money candy to play**

---

360 8. The boy stood on the burning deck,
367 Whence all but he had fled;
373 The flame that lit the battle's wreck,
380 Shone round him o'er the dead;
386 Yet beautiful and bright he stood,
392 As born to rule the storm.

398 What word best describes the boy?

404 **cowardly mischievous brave young good**

---

409 9. At every turn the maples burn,
415 The quail is whistling free.
420 The partridge whirrs and the frosted burrs
427 Are dropping for you and me.

433 What season of the year does the stanza tell about? Draw a
445 line under the one you think.

451 **spring summer autumn winter**

---

455 10. Aladdin's uncle said: "I will take a shop and furnish it
466 for you." Aladdin was delighted with the idea, for he thought
477 there was very little work in keeping a shop. He liked that bet-
489 ter than anything else.

493 What kind of a boy was Aladdin?

500 **industrious ambitious active lazy honest**

---

505 11. The caravan, stretched out upon the desert, was very pic-
514 turesque; in motion, however, it was like a lazy serpent. By and
526 by its stubborn dragging became intolerably irksome to Balthasar,
535 patient as he was.

539 Place a line under the word which tells in what respect the
551 caravan resembled a serpent.

555 **temper color length motion size**

(Turn to next page.)

560 12. He was lying alone, one sunny spring day, on a mossy
571 bank beside the clear stream flowing past with steady, ceaseless
581 motion. He had his book open in his hand, but he was not reading.

595 Draw a line under the word which tells why he was not read-
607 ing.

608 frightened asleep hungry cold unhappy

613 13. As a race, the Indians have withered from the land. Their
624 arrows are broken, their council-fire has long since gone out on the
636 shore, and their war cry is fading to the untrodden West. Slowly
648 and sadly they climb the distant mountains, and read their doom in
660 the setting sun.

663 How do the Indians feel?

668 happy angry excited sad tired

---

673 14. In front the purple mountains were rising up, a distant
683 wall. Cool snow gleamed upon the summits. Our horses suffered
693 bitterly for water. Five hours we had ridden through all that arid
705 waste without a pause.

709 What kind of a country had these people been riding through?

720 mountainous swampy desert forest valley

---

725 15. Tracking was very difficult. As there was total absence of
735 rain, it was next to impossible to distinguish the tracks of two-
746 days' date from those most recent upon the hard and parched soil.

758 Draw a line under the word below that tells what it was that
771 made tracking difficult.

774 mud snow drouth rocks grass.

779 16. The soldier crawled out of the trench, where he had spent
790 the night. He was covered with mud from head to foot, and al-
802 most frozen. He looked around at his companions. What a mis-
812 erable lot they were!

816 How did the soldier feel?

821 happy patriotic brave angry downhearted
826

Test No. 1—ADDITION

No. Right ....

7862	6809	8941	5917	6772	7864	1249
5013	7623	7910	4814	6028	7883	8975
1761	5299	9845	9007	6535	8240	9005
5872	6601	8522	6975	2340	9869	1573
3739	3496	1046	1227	2319	6794	3203

8758	2462	1247	4319	6794	3293	7917
2350	9869	3573	2358	5420	7805	4304
3197	4572	1081	5795	4570	7642	9027
2338	6420	7805	4314	8028	7803	9975
5917	6772	9864	1249	8758	2462	1247

Test No. 2—MULTIPLICATION

No. Right ....

4857	5718	6942	4065
36	92	58	47

9625	6123	7486	9027
23	64	75	89

1253	5376	3786	5492
38	76	49	53

8246	5739	7593	2648
29	85	64	27

Test No. 3—DIVISION

No. Right ______________

41)574	79)36893	32)384	58)27608
84)1932	98)46844	21)966	68)31824
42)546	96)56064	73)6278	28)21980
52)624	89)25365	23)713	76)36708
31)2263	48)32304	51)918	67)39932